Teacher's Manual for

UNSHINE AND RAIN

The HOW AND WHY ScienceBooks

A TEACHER'S MANUAL
AND SCIENCE HANDBOOK
to accompany

SUNSHINE AND RAIN
PRIMER

of the

HOW AND WHY SCIENCE
SERIES

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THE HOW AND WHY SCIENCE BOOKS

WE SEE (PRE-PRIMER)

SUNSHINE AND RAIN (PRIMER)

THROUGH THE YEAR (GRADE 1)

WINTER COMES AND GOES (GRADE 2)

THE SEASONS PASS (GRADE 3)

THE HOW AND WHY CLUB (GRADE 4)

HOW AND WHY EXPERIMENTS (GRADE 5)

HOW AND WHY DISCOVERIES (GRADE 6)

HOW AND WHY EXPLORATIONS (GRADE 7)

HOW AND WHY CONCLUSIONS (GRADE 8)

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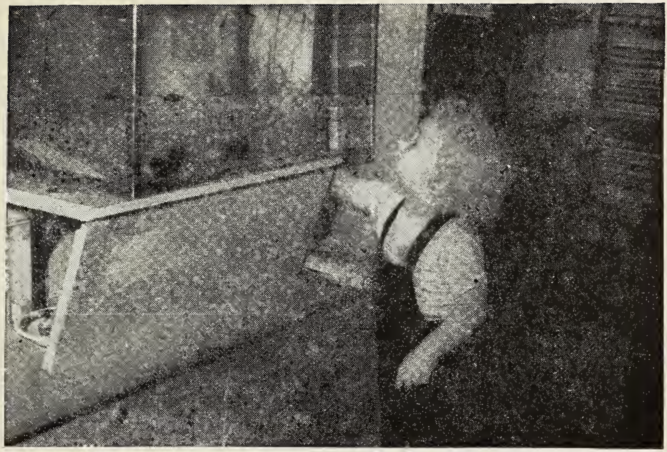


"All knowledge begins in wonder."

ELEMENTARY SCIENCE

THE PHILOSOPHY OF SCIENCE TEACHING

Someone has said, "All knowledge begins in wonder." A child entering school for the first time brings with him spontaneous enthusiasm and interest in the world about him which manifest themselves in an eagerness to relate his experiences. He is full of questions about the caterpillars, frogs, turtles, and other live things that he finds as he plays. He is curious about the weather, the heavenly bodies, and other physical phenomena of his environment. He asks how and why the mechanical devices of his everyday experiences work.

Too often this natural curiosity of the little child is lost instead of being developed during the first few years of school life, because teachers and parents feel their inadequacy to meet the situation. The knowledge required to answer all these questions is so great as to discourage the average adult. When children are curious, they have no respect for the lines of subject matter. One question may fall in the field of biology; the next in physics or chemistry. To

answer all questions completely might well require more knowledge than even a specialist would possess.

However, to teach science to children it is not necessary to be able to answer all their questions. The alert teacher with abundant enthusiasm and curiosity can help them find the answers to many of their own questions. Nowhere will her efforts bring more satisfying results than in the teaching of science.

The philosophy of science teaching differs very little from that of any other subject. It is the subject matter which makes the handling of it more difficult, because teachers are not generally trained for science teaching. The teacher must take into account those things in the child's experience which lie in the field of science. There are many experiences common to children everywhere that may become the foundations of our science work. From these common paths teachers may diverge with the interests of individuals and the groups, and adapt the teaching to the local community or section of the country.

We live in a world that is changing so rapidly that what is grist for the science mill today may become a waste product tomorrow. One day a Byrd explores Antarctica; a Beebe explores the depths of the ocean; or a Piccard penetrates the stratosphere. At such times even first-graders may discuss the stratosphere but to put the stratosphere into a first-grade book, in the light of our present knowledge, would be questionable.

Again, the children we teach are affected by varied environments. Those of the western plains have a whole set of animal concepts not possessed by children of the Atlantic coast. Children in a mining town, children from the country, children from a metropolis—all have experiences which give them different ideas. But through all these experiences the teachers may teach the same scientific principles. For example, hibernation of animals may be taught to a western child by a study of snakes; to a child in the lake region by a study of frogs; to a child somewhere else by the study of clams, crayfish, or some insect.

In science, the teacher needs to remember individual differences. Some children respond more freely to experiences with plants, some to animals, some to physical science. By encouraging children to express themselves freely in the classroom, and to experi-

ment for themselves with the materials found in the science room, the teacher can discover these differences and make effective uses of them.

Above all, to be a successful teacher of science, one must be enthusiastic about the subject, enjoy working with children, and understand the way they think. She must be scientific in her own attitudes and be able to use the problem-solving method of teaching. She does not have to be a specialist in science nor be afraid that she won't know all the answers. She probably won't be able to answer all the questions which the children ask, but even if she can, to do so would spoil the fun for the children. She need not hesitate to say, "I don't know," providing she continues, "but we'll find out together." Science teaching can be a shared experience of teacher and children that has great possibilities for both.

OBJECTIVES FOR TEACHING SCIENCE TO CHILDREN

Science for the grades should not be regarded as a mere accumulation of facts but as a series of experiences with the science materials that are a part of every child's daily life. These experiences stimulate the curiosity of children and if used properly should lead to behavior changes in the children. To accomplish desirable outcomes the teacher should understand the reasons why anyone studies science. These reasons may be called objectives. Scientists differ in the way they state these major objectives, but they agree on their content. Briefly stated, these objectives of elementary science are:

1. To develop an intelligent appreciation of the natural and physical world.
2. To develop scientific attitudes.
3. To help the child acquire the scientific method of problem solving.
4. To help the child acquire useful knowledge of scientific principles.

By an intelligent interest and appreciation of the world in which he lives, a child is made aware of real beauty that goes deeper than

the mere appeal to sense. Appreciation grows as knowledge is gained. The person who gets a satisfaction from the color and form of a beautiful butterfly should enjoy it more after seeing it go through its transformation from pupa to adult. The child who, looking intently at a butterfly's chrysalis, exclaimed, "Oh, I can see the wings through the chrysalis skin!" was experiencing appreciation. Children should get a thrill out of their science experiences which will make their lives richer and more enjoyable.

Appreciation should lead to the conservation of wild life. The biological principles of the struggle for existence and survival of the fittest make for a balance in nature, unless it is upset by man. Through experiences with material such as that used in "Insects in the Garden," "Birds in the Orchard," and "Life in the Pond," children may be led to see the relationships of plants and animals. They learn which ones are harmful, and what to do about them, as well as which ones are helpful to man.

The second objective, that concerning scientific attitudes, should run through all science teaching. The child who has these scientific attitudes:

(*a*) Will have a conviction of basic cause-and-effect relation which will make it impossible for him to believe in superstition or unexplained mysteries.
(*b*) Will have a sensitive curiosity which will lead to making accurate observations, collecting data, and searching for adequate explanations.
(*c*) Will have the habit of delayed response, preventing him from making snap judgments or jumping to conclusions.
(*d*) Will weigh evidence carefully to find out if it is sound, pertinent, and adequate.
(*e*) Will have respect for another's point of view, being willing to change his point of view in the face of new evidence.

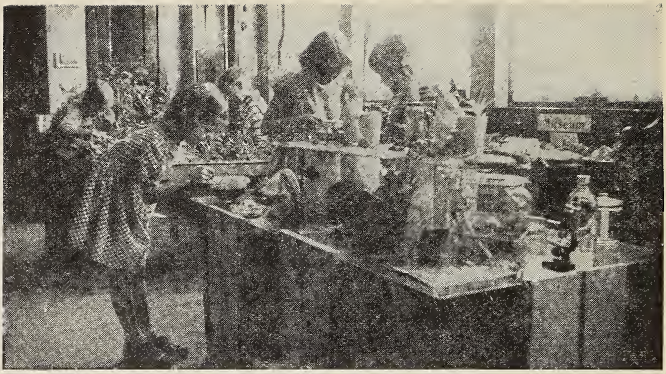
These may sound formidable to the teacher who has had little training in science. She may recognize them as desirable outcomes, yet not have the slightest idea of how to go about teaching them. She need not be frightened, however, because the techniques by which she helps children develop scientific attitudes are

very similar to those she uses to develop social attitudes. The first step is to be able to recognize a *lack* of the attitudes.

For example, a child who says, "My grandmother says the ground hog saw his shadow and he can tell about the weather," does not have the attitude of looking for a cause. The teacher could help him develop the attitude by saying, "That is interesting. I wonder what makes your grandmother think that," or, "I wonder what the ground hog (woodchuck) knows." The child may answer, "If he sees his shadow on ground-hog day, we'll have six weeks of bad weather." Then the teacher may say, "That may be true, but what do the rest of you think about it?" After a brief discussion she may say, "All of you are just giving ideas. Is that the way scientists (or people who study woodchucks) would settle a question?" The children may suggest watching for woodchucks or discussing the weather on February 2—will the woodchuck see his shadow or not? They may watch the weather for six weeks, recording it and comparing the actual weather with the woodchuck's "prediction." Some child may be bright enough to remark, "It may be cloudy in the fields south of town and the sun may be shining on the north side. The north side couldn't have six weeks of bad weather while the south side is having good weather." The grandmother (who would have resented it had the teacher said, "That idea is not true, Tom,") may become interested in a long-time experiment; but, whether or not there is hope for grandmother, Tom's plastic mind has been affected by six weeks of observing and checking.

Later when Dick insists that horsehairs turn into snakes, Tom will be eager to bring rain water and a horsehair to find out if Dick is right. Bit by bit, these experiences will straighten out Tom's thinking until one day he will say, "I don't believe in superstitions. One day when we were out driving, a black cat ran across the road. Later we had engine trouble, but the trouble was caused because a part had worn out."

Not only is this attitude taught by correcting existing superstitions and misconceptions, but it impels children to look for the causes of all natural phenomena. Numerous opportunities arise every day to develop it. For example, in trying to solve the problem of why food spoils, the teacher may ask, "Where does your



Independent investigations.

mother put food that she wants to keep?" Through discussion someone may say, "Temperature will affect food. When food gets hot, it spoils." In problem solving there are many opportunities to teach scientific attitudes.

The ability to interpret natural phenomena correctly does away with unreasoning fears. The child who understands the cause of thunder, and has demonstrated it in a small way by clapping his hands, is not so likely to be afraid of the noise. Knowing that animals are not likely to sting or bite except in self-defense, he is less susceptible to the fear carried by many people into adult life. The person who has studied about meteors and northern lights doesn't assign mysterious reasons or results to these natural phenomena. The child's understanding of the cause and prevention of disease helps keep him from carelessly exposing himself and others, as in the case of colds. He learns that everything has a cause; that disasters don't just happen, nor, as was once believed, are they visited upon us as punishment.

Curiosity concerning their environment is natural to children, though some have more of it than others. But sensitive curiosity may have to be taught. Children ask many questions to which they really don't expect an answer, nor care for one. Sensitive

curiosity is demonstrated by a perseverance on the part of the child in asking a question, or in independent investigation on his own initiative. Children should be given opportunities to tell of things they observe that stimulate their interest and curiosity. If learning is dependent upon desire to know, then curiosity is a valuable attitude to develop. Some children have it to such a degree that no amount of squelching on the part of adults will stop their investigations. They learn in spite of their teachers. Other timid ones stop asking when they get no satisfactory explanation. The child who persisted in saying, "I *want* to *know* what makes the bubbles in cake," after the teacher had told her it was too hard for her to understand, had unquenchable curiosity.

The ability to make careful, accurate observations and the ability to collect data are outcomes of the attitude of sensitive curiosity. Some teaching techniques which help in the teaching of this attitude are:

(*a*) Making use of the children's suggestions of ways to collect data—for example, when Mary wonders what will happen if a prism is held in a cloud of dust while a sunbeam is striking it, let Mary try it, using chalk dust.

(*b*) Insisting upon accurate descriptions when a child reports having seen something—for example, when a boy describing an insect the size of a gnat, tells of a yellow stripe around its body, the teacher may say, "Just a minute. How could you see the yellow stripe on an insect no larger than a gnat? Tell just what you saw. If you didn't see the color, don't tell about it."

(*c*) Setting an example of collecting data by asking questions about many points which the children have not mentioned in their descriptions.

(*d*) Insisting upon experimentation or demonstration being directed to the purpose of gaining adequate explanations. Children are likely to become more interested in the working of the apparatus than in the answer to their original question. Then the teacher may say, "Why are we doing this experiment? Is it helping to answer the question? It is an experiment only as long as you are learning. After that it is play."

The attitude of delayed response is developed by insisting on the children's not "jumping to conclusions." The child who says, "I saw a bird. I *think* it was a woodpecker because it was tapping on a tree," or "I *think* the fish died because we didn't put any green stuff in the aquarium like we do at home," or "I'm *not sure,* but I don't think the air does all of the work of holding the plane up," has developed the attitude. The child who says, "I *know* that was a fallen star. There are a lot of them around here," hasn't developed the attitude.

To help develop the attitude of delayed response, the teacher must be on the alert with answers such as:

"We must be careful and not think we have found out something when we really haven't."

"Do you think you should say they are fallen stars? Has anyone proved it?"

"Let's save that question and answer it later. Then we will find out more about it to help us be sure." (And don't forget to do it!)

Having developed the attitudes of basic cause and effect, sensitive curiosity, and delayed response, children are ready for weighing evidence. Children are usually eager to express their ideas without thought as to whether they are pertinent or sound. When the teacher is just starting her science program, she may encourage expression to get things under way. After the ice is broken and the children are no longer inhibited or shy, the teacher has to curb their enthusiasm and direct their thinking.

To do this without breaking their line of reasoning takes skill. The teacher must not be discouraged if her first attempts at developing attitudes result in confusion. She may have to go back to the beginning of the lesson and start over. When this happens, the teacher should take the children into her confidence by smiling and saying, "I guess I got us off on the wrong track. Let's see where we were," or "We're all mixed up. You'll have to help me. What were we trying to find out?" The children will respond to this.

Some ways to help develop this attitude of weighing evidence are to give suggestions like:

"Let's remember not to take too much time with details that don't really have anything to do with our problem."
"Does your question have anything to do with electricity? Have you thought it through?"
"Do you think that we have enough information to answer the question?"
"Should we decide before we know what a scientist has to say about that?"
"Let's keep our minds on one track."

By consulting an authority, the teacher should check often on the accuracy and soundness of the experiments being done. The children should check with their science text. They should never draw conclusions from one experiment.

A child who has developed this attitude will say things like this: "I think the tooth comes from the upper jaw by the way it curves. If you'll look at a dog's teeth, you'll notice that the upper teeth curve down over the lower teeth. It's hard to tell whether it's the upper tooth of a big bear or the lower tooth of a small bear," or "We haven't read it carefully enough. He forgot to use a marker so I don't think it would be right."

Willingness to change one's opinion in the face of new evidence is the most advanced attitude of all. The person who has it is tolerant, without prejudice and bigotry. If all the children in the world could really be taught this attitude so that it would function, wars would cease. Science has no monopoly on this attitude, but it offers an excellent opportunity for its natural development. In social studies areas, emotions are more likely to be involved. In solving science problems, children can be more objective. The teacher may say:

"There is a sentence on that page that isn't exactly scientific. Scientists have found out more about it since the book was published."
"When one has the floor, let's remember that others want to talk also, and not take too much time."
"Don't laugh. I'm not surprised that he's mixed up. Grown folks get mixed up, too."
"Do we laugh at people who have ideas?"

"Let John have his chance. Let's listen to what he has to say."
"I think he has an idea, but it just isn't very clear."
"Evidently there are three people who do not agree."
"Jane listened to you; now it is her turn."

Allow every child an opportunity to tell one thing he has observed or learned from an experiment. Give careful consideration to every child's serious question or attempt to explain something. If the teacher respects children as individuals, respects the importance of their problems, and is willing to change her own mind when she sees that she is wrong, it will help in teaching this attitude.

The child who has this attitude will say, "I don't quite agree with her because I think there is a change in the temperature of the land," or "I thought the candle wick burned, but now I know that it is the gas that burns."

Children often have pretty definite ideas about their experiences and are not willing to change those ideas. For example, many people use widely advertised products in their homes without investigating their true value. One science group made a study of some of these products and discovered that the advertising was misleading. The children in the group were learning to evaluate and test statements in the light of evidence.

Willingness to change opinion, to search for the whole truth, and to base judgment on fact are all closely related and may be developed together. They may all result from a comparison of experimental data or accurate observations.

A child may have formed some incorrect idea that he has heard or read in a book. For example, a child insisted that "beavers carry mud on their tails" because he had read it in a children's storybook. The other children challenged his statement. The teacher asked how they could know whether or not the statement was correct. The children said to ask a scientist or look it up in several books written by scientists who had studied beavers. When this was done, the child who had made the statement saw that his idea was wrong. He also realized that he could not believe everything he read.

Many elementary teachers have themselves not had the advantage of science training and do not know how to teach by the problem-solving method. Although it is not unique to the field of science, the average elementary teacher may not have learned the techniques necessary to help children learn it and use it. Even if teachers have used problem solving in teaching social studies or arithmetic, unfamiliarity with the science fields may make them hesitate to apply it in that area. Yet science problems are such a natural part of every child's world that the questions he asks are the easiest approach to the development of these particular skills and habits. Since educators agree pretty uniformly that our major objectives lie in the areas of appreciations, attitudes, skills, and habits rather than in subject matter as such, the training of children in the problem-solving method seems very important.

The first thing that a teacher must do before starting to help children learn problem solving is to be able to recognize good problem situations and good problems. Among the questions that children ask are many that are of passing interest and may be answered quickly and easily. But often some of these questions offer opportunities for real problem solving.

For example, a group of first-graders, during their science meeting were reporting their observations of natural happenings. Some of the questions about an icicle that one child showed were:

1. Can you see through that ice?
2. Why is the ice frozen around the stick?
3. Would it freeze again if we put it out today? (The icicle was melting.)
4. How was the icicle made?

The teacher recognized number four as a good problem to help the children start developing some skills, so she used it. The other questions were used in developing the problem.

Some of the things to keep in mind when selecting a problem from children's questions are:

1. Is it suitable for the age level of the child who is trying to solve it?

2. Is it worth spending time on?
3. Are the materials available with which to solve it?
4. Does it offer opportunities for many child activities?
5. Are the children interested in it?
6. Can it be solved within the interest span of the group?
7. Does it contain the elements that make it a real problem to the children?

To illustrate these criteria let us test the problem, "How was that icicle made?"

With a group of children who had had no previous experiences with ice, the problem might have been too difficult. To know this a teacher needs to analyze the problem for the concepts necessary to its understanding. Some of these concepts in this case are:

1. Ice is frozen water.
2. Water freezes out of doors in winter.
3. Heat melts ice.
4. Sunlight gives heat.
5. Snow is frozen water.

The first grade which asked the question about the icicles had developed these concepts in the kindergarten, so this problem was suitable for their group. The problem might have been just as suitable for a fifth or sixth grade which had not had the science experiences of this first grade.

Testing the problem by the second criterion, "Is it worth spending the time on it?" one might say that it isn't very important to know how icicles are formed. Certainly many adults are leading happy, useful lives without the knowledge. We can't justify the value of the problem by the knowledge objective.

From the standpoint of appreciation, icicles are beautiful. That is one reason they attract children. Icicles are also interesting and arouse curiosity. Curiosity, if properly directed, leads to the scientific attitude of sensitive curiosity. Besides these values, the fact that the children are trying to find an answer to their own question makes it an ideal way to develop problem-solving skills.

The third criterion, "Are there materials available with which to solve it?" is satisfied, since in winter we have temperatures for simple experiments with freezing. The fourth criterion, "Does it

offer opportunities for child activities?" is met in that all of the experiments, demonstrations, and observations needed for solution are easily done by six-year-olds. It satisfies number five, "Are the children interested in it?" because the children initiated the problem.

Criterion number six, "Can it be solved within the interest span of the group?" is satisfied at whatever age level we are solving the problem. In the first grade which raised this problem the interest span was rather short. The group met with the science teacher only once a week for a twenty-minute period. Yet for two or three weeks the children kept bringing icicles of different sizes and shapes to the science room, commenting upon them in such a way as to demonstrate an understanding and an appreciation of their formation. Of course their understanding was not as complete as that an older group would have, but as far as it went it was correct.

To check with criterion number seven, "Does it contain the elements of a real problem?" we must analyze what we mean by the elements of a good problem. Why is "How was that icicle made?" a good problem while "Can you see through the ice?" isn't so good?

In the first place, a problem must present an obstacle in thinking. "Can you see through the ice?" presents very little difficulty because to answer it the child merely holds the ice up and tries to look through it. There is no need for the problem-solving technique. The other question cannot be answered so readily. Unless the children have already met the question before and had it answered, they must discuss it and give possible answers based on their previous experiences. Then they must test these possible answers in various ways, finally drawing conclusions from the results of their data. True, this will be done very simply in the first grade, but by repeated learning situations of this kind even six-year-olds begin to develop these skills and habits.

Elementary teachers often say, "It is all very well for a science teacher to talk about these methods of teaching science to children, but theory and practice are two different things. *We* have to teach the children." Elementary teachers are justified in this criticism. Too often college teachers have a tendency to deal with

ideas and theory, neglecting contact with practical teaching situations.

For that reason let us examine several actual problem-solving lessons as taught at different grade levels, for the teaching skills needed to teach them.

The first one was taught in a first grade, and used only the materials of the environment. The problem was child-initiated when there was a hard rain and the children found earthworms on the sidewalk.

Problem: Why do earthworms come out of the ground when it rains?

Analysis:

Teacher's questions—

1. Where do earthworms usually live?
2. What must live things have in order to live?
3. What ideas do you have about why you found the earthworms on the sidewalks?

Hypotheses or possible answers given by the children were—

1. Maybe the earthworms want water.
2. Maybe the earthworms come out to breathe.
3. Maybe there is too much water in the ground so the earthworms will drown if they don't come out.
4. Maybe the earthworms' homes are ruined by rain and they have to come out.

Solution:

A. Gathering data:

The teacher asked the children to suggest ways of finding out whether or not their answers were correct. As a result of the discussion, the children did these activities.

1. They put some earthworms on top of some soil and watched them burrow into the ground.
2. They examined some soil with a hand lens to see the spaces between the soil particles.

3. They put soil in water and saw bubbles of air escaping.
4. They poured water into a glass jar of soil until all of the air had bubbled out of the soil and water was standing on the soil.
5. They found earthworms in puddles where they had been unable to find drier soil.
6. They put water into the jar containing the earthworms and watched the earthworms.
7. The teacher drew an enlarged diagram of an earthworm's burrow to illustrate the relative sizes of worms to soil particles and air spaces.

B. Results:

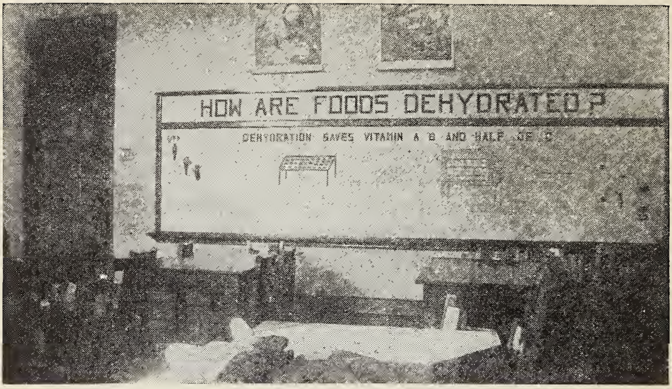
1. The earthworms burrowed into the moist soil, head end first.
2. The soil particles looked like tiny rocks.
3. & 4. Bubbles of air were plainly seen.
5. The earthworms in the puddles were dead.
6. As the water filled up the spaces between soil particles and air came out, the earthworms came to the surface and crawled out of the jar.

CONCLUSIONS:

When the earthworm's hole was full of water, it couldn't get air so it crawled out. When the ground was dry it would crawl back into its hole. If the earthworm couldn't get back into its hole and the ground was covered with water, it died.

This was a very simple problem but it offered all of the elements of real problem solving on a six-year-old level. The information could be gathered by the children themselves and was concrete enough for them to draw correct conclusions. They could check their results with those of the children in the story of earthworms in THROUGH THE YEAR.

This problem-solving lesson has illustrated the utilization by the teacher of a child's question for accomplishing her own objectives. We cannot always wait for questions to arise naturally to



As children grow older, their problems enlarge.

initiate science problems. The teacher must know the problems that are suitable for the group she is teaching, and at times she must create situations to motivate the setting up of these problems. Once initiated, the science program will usually keep going under its own power. New problems will grow out of those in the process of solution. The teacher and children will find themselves with more problems than they can possibly solve in the time they have. These problems should be recorded and used to start another year's work, or handled through individual or group reports.

As children grow older and develop more skill in handling problems, their problems will enlarge. They may break down these larger problems into minor problems to be solved. The time taken for solution will increase and the children may be taught to recognize the steps in their thinking. They may begin to record their data. This will be a group activity at first, with the teacher writing on the board the simple statements made by the children.

For example, a second grade in trying to answer their questions of "How did this piece of salt get on the shore of Salt Lake?" did some simple activities to clarify the concepts of *solution* and *evaporation.* At the end of one activity the teacher wrote the following results on the board as the children gave them to her.

1. Salt dissolves in water.

2. We couldn't see the salt in the water.
3. When the water evaporated we saw the salt again.

These children were able to check the results of this activity by reading in their second grade science text, WINTER COMES AND GOES.

Third-graders have developed enough reading skill to be able to supplement their own observations and experimentation by reading. They are also able to begin writing a few sentences as a record of the conclusions to their problems. The teacher should handle this just as she does the written language work the children do, being sure that the conclusions recorded are correct.

Analyzing problem solving for some of the difficulties that arise in teaching it, let us look at a rather simple lesson, "Why does a candle burn?" What are the concepts and skills a child needs for setting up the hypothesis and solving it? Some of the concepts needed are:

1. A candle is made of wax.
2. Wax is a solid.
3. Wax melts when heated.
4. Solids may be changed to liquids by heating.
5. Liquids may be changed to gases by further heating.
6. There is something in all fuels that burns.

Some of the skills the child will need are:

1. Ability to handle the simple apparatus needed.
2. Ability to observe accurately.
3. Ability to work carefully.
4. Ability to draw correct conclusions from accurately observed results.
5. Reading and language skills necessary for checking his results and recording them.

The teacher has to anticipate all of these needs and plan carefully. She must realize the safety measures to be provided in any experiment involving fire. She must guard against unscientific attitudes, such as drawing conclusions with insufficient evidence. She must be alert at every step in the procedure for opportunities to develop scientific attitudes and good habits of thinking.

Perhaps this all seems like a very complicated and difficult task to the teachers who have not used the problem-solving method. It would be if you started out trying to teach it all at once. If you begin slowly, one step at a time, you will find the children co-operating eagerly. The satisfaction gained by feeling that you are teaching habits of thinking that the children will be using long after they've forgotten some of the bits of information makes the effort worth while. A child's spontaneous comment at the end of the solution of the problem, "Why do teeth decay?" illustrates this point. It had taken some time to finish and the teacher was feeling a bit discouraged at the seeming waste of time. The child wrote his last sentence of the conclusion with an audible sigh of satisfaction and remarked, "Boy! I call that finishing a real job. That's really getting something when you find out yourself instead of just reading." When the children themselves realize the value of their learning, it must be worth while.

These values, in part, are:

1. The ability to recognize and formulate problems.
2. The ability to set up reasonable hypotheses.
3. The ability to gather data by means of suitable activities for testing the hypotheses.
4. The ability to record accurate results.
5. The ability to generalize from results, draw correct conclusions, and check with an authority.
6. The ability to apply the conclusions to similar problems.

In addition to these skills and habits, scientific attitudes and knowledge are gained in the solution of pertinent problems.

A science room.

SCIENCE ACTIVITIES COMMON TO ALL GRADES

THE SCIENCE ROOM

The problem of how to care for materials and specimens is a real one for the grade teacher. If there is a separate science room, these may be cared for in the cabinets, display cases, and closets provided for them. If not, some space must be allotted in the regular classroom. They need not take up much room, for the apparatus needed for teaching elementary science is simple. A few glass jars, dishes and bottles, a few tin cans, some pieces of wire netting, cheesecloth and some candles may be the only things needed. An electric plate, alcohol lamp, or some other source of heat is necessary for some of the experiments suggested. But if these are not available, other common experiences may be substituted. In some schools it is against the rules to have fire in the classroom. Unless an electric plate can be obtained, the radiator is the only source of heat. There is such a variety of home-made equipment and substitutes for expensive apparatus that the ingenious teacher can always find some material for her activities. Running water is a great convenience. The children should have

Shelves provide places for permanent collections.

a share in assembling needed apparatus but the teacher must be responsible for seeing that it is ready when it is needed.

The regular classroom may be made more attractive with a few well-kept aquaria, terraria, and growing plants. Suggestions for maintaining these in good condition are given in other parts of this Manual. A science table will provide for the specimens of rocks, insects, birds' nests, and other things the children collect and bring to school. It should be well kept and cleared at intervals. As a child brings in his contribution it can be discussed, named, and put on the table with a small sign telling what it is and the name of the donor. A few cases of shelves will provide a place for more permanent collections.

A table with a few interesting things that the teacher provides helps to stimulate science work. These specimens should have labels telling enough about them to arouse curiosity and a desire to know more. For example, an oyster shell may be labeled, "This is the outside of an animal. It lived in the sea. It is used for food. You have a relative of this *oyster* in your aquarium. Do you know what it is?" The relative is a snail or perhaps a clam.

In some schools, glass display cases in the hall offer a place where science material may be exhibited. These exhibits should be changed frequently. For example, a group of children may

be studying rocks. They may put some of their best specimens, with neat labels, in the hall case. Other children of the school will enjoy this display and learn from it.

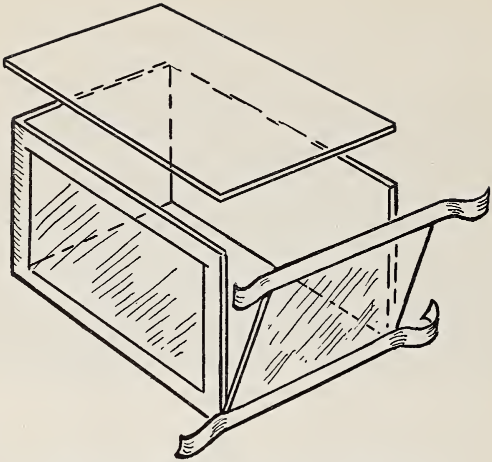
If the teacher wishes to buy equipment she may order it from any one of several scientific supply companies. Many of the things she needs such as dry cells, wire, and magnets may be bought at local ten-cent stores.

Bulletin boards are an important addition to the science room. They may be used by the children for the clippings and pictures they bring to class. The teacher may use them to motivate units or lessons, or to display summarizing activities at the end of a unit. They may be used for pictures of birds, wild flowers, or other aids to identification. There are many charts, such as the Audubon Bird Charts, which may be used for the same purpose. Bookshelves for reference books and magazines and a case for maps and charts should be provided.

Science material, whether it is alive, or is physical apparatus, must be kept in good condition. Nothing is so likely to kill the interest in science as dirty glassware standing around the room, cloudy aquariums, boxes of dead caterpillars, or unhealthy animals. There is much plain housekeeping in the science room, but all of it can be used to help teach children careful habits, particularly if the children are given the responsibility of helping to do this housekeeping.

HOW TO MAKE A TERRARIUM

A simple terrarium has so many uses that it is well to know how to make one. First, it is necessary to have a container. A glass jar of any kind will do, but one with straight sides is better than a round one. A glass box may be easily made from six pieces of window glass cut to the desired size. These may be fastened together with one-inch adhesive tape or black *passe partout* tape. Rub the tape until it sticks firmly to the glass. The lid may be fastened so that it is hinged, or merely laid across the top. All edges should be bound with tape to prevent cut fingers. A further precaution is to have the edges of the glass beveled at the time it is being cut.



A terrarium made from glass and adhesive tape.

A wooden base instead of a glass one may be used for the box. If wood is used, it should be so cut that at least one inch will project from around the glass at the bottom. The board may be treated with melted paraffin to make it resistant to water. A half-inch furrow should be sawed in the wooden base, the dimensions of the glass, and made wide enough to take the glass. The glass sides can be more firmly secured in the furrow by means of aquarium cement or putty. Adhesive tape may be put around the top to make smooth edges.

Having a container, start making the terrarium by putting a layer of gravel in the bottom, to provide drainage. Small pieces of charcoal will help keep it sweet. On top of the gravel put soil of the kind found where the plants grow which are to be used in the terrarium. For example, moss and ferns come from the woods. Use woods soil, or leaf mold, for a woods terrarium. Use garden loam for a garden terrarium. Use sand for a desert terrarium.

In the soil plant the moss, ferns, or other plants you wish to use. If you are going to put animals which eat plants into the terrarium, some of these food plants should be planted. For example, if

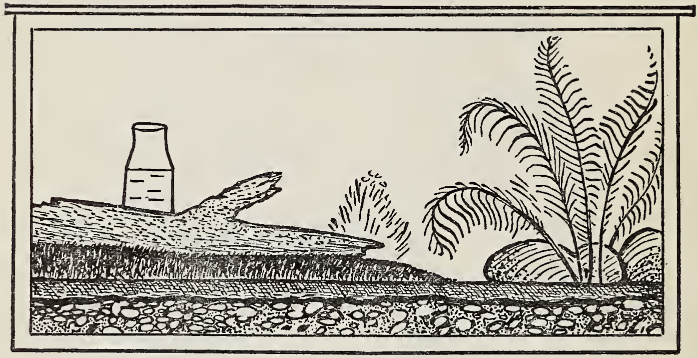
Making a terrarium for a garter snake.

making a home for grasshoppers, plant corn or oats and let it sprout before putting in the insects. For toads, use garden soil, a dish of water sunk into it, with perhaps some stones and a little grass. The toad will bury itself in the soil. Salamanders like moist moss and pieces of decaying wood under which to bury themselves. Lizards and horned toads will bury themselves in the sand of a desert terrarium.

The terrarium should be kept out of strong sunlight and in a place that is not too warm. It should be sprinkled with water when first made, if it has plants in it. After that it should be sprinkled only when the cover gets dry on the underside. Water should be kept in a dish if there are animals in the terrarium. Snakes go into water, and a tall container like a pint milk bottle or pickle jar of water will make them comfortable. A low dish is better for turtles and toads. This can be placed in one end of the

terrarium and stones and soil built up around it to the level of the top of the dish.

A single terrarium should not contain a large variety of animals. Since boxes of glass and adhesive tape are practical and inexpensive, it is better to have several, each one containing a different kind of animal.



A woods terrarium.

The food of frogs and toads in the wild state consists of insects, worms, caterpillars, snails, and slugs. They also eat flies, mosquitoes, and gnats. These can be easily provided, but they should always be alive. Frogs and toads will not touch dead worms or insects. They will starve in a terrarium if they have no live food to eat. A fly trap can be made and once a day the flies released from the trap into the terrarium. When there are insects out of doors, they may be caught by sweeping the grass with an insect net. In winter when flies are scarce, meal worms and meal bugs, which can be cultivated in bran flour, can be substituted.

Newts and salamanders can be fed on bits of raw meat, fish, oysters, scrambled eggs, worms, or insects. Land turtles are plant-eaters, using tender plants and berries for food. Water turtles are meat-eaters, using earthworms, insects, crayfish, and small fish. Mud turtles do not eat unless they are under water. Horned toads eat living insects. Garter snakes eat earthworms, insects, frogs,

salamanders, and toads. Snails are vegetarians; lettuce is a good food for them.

Care should be taken that an excess of uneaten food does not remain in a terrarium. Terrariums should be kept clean so that the captive animals may live in healthful conditions.

HOW TO MAKE AN AQUARIUM

Almost any container that holds water may be used for an aquarium, but a straight-sided one is best. The globe-shaped ones afford too little water surface for the absorption of air and they distort the shape of objects inside the aquarium.

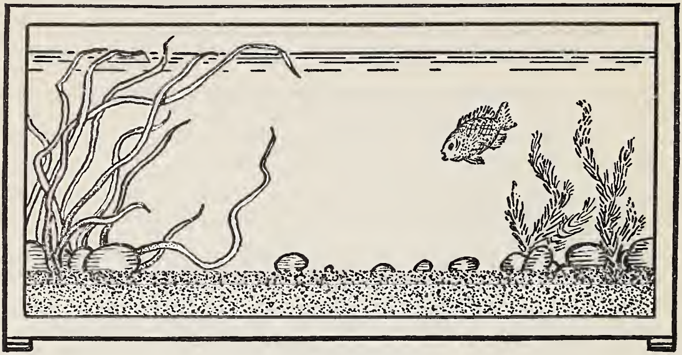
The container must be very clean, and the sand must be thoroughly washed. Sand may be washed by running a stream of water into the pan of sand until the water runs out clean. If the sand is then baked in an oven, any bacteria or mold spores will be killed.

Enough sand should be put into the bottom of the aquarium to insure a good root-hold for the plants. Elodea, eelgrass, and water milfoil are all good aquarium plants and are common in most of our fresh-water lakes and streams. These are satisfactory for summer aquariums but they do not always survive the winter. There are many inexpensive tropical water plants which can be used. Such varieties as Valisneria, Cabomba, Myriophyllum, and Sagittarium are commonly obtainable. It is believed that Valisneria is the best oxygenating plant. This is a grasslike plant which grows very quickly. Duckweed is a small leaflife plant that is often found floating on ponds. It is attractive in an aquarium, though it doesn't help to supply much oxygen.

The plants should be planted in the sand, then anchored with stones. Water can be poured into the aquarium without disturbing the plants by putting a piece of paper on the sand and pouring the water on the paper, or a dish may be placed on the sand into which the water can be poured.

Clean pond, lake, or rain water is best for an aquarium because it contains minute organisms that may later feed the animals. If tap water must be used, allow it to stand several days before putting it into the aquarium. This allows any lime that might spoil

the sides of the aquarium to be deposited and frees the water from any chlorine that has been added for purification. After adding the water, allow the plants time to become rooted before putting



A simple aquarium.

in the fish or tadpoles. Otherwise the animals may pull up the plants.

One rule for the number of fish in an aquarium is one three-inch fish to a gallon of water. Another rule is an inch of fish for each 20 square inches of water surface at the top. Most people are inclined to put more fish into an aquarium than the amount of water justifies.

Any kind of aquarium fish such as goldfish or tropical fish may be put into an aquarium. However, tropical fish are more difficult to keep than goldfish, and require more attention. The water temperature must be kept above 65° for tropicals, and the feeding must be more regular.

Of the tropical fish, guppies, swordtails, and paradise fish survive well and they have interesting habits. Guppies and swordtails are livebearers. Under favorable conditions, guppies reproduce every six weeks. The bubble-nests of the paradise fish are interesting. Tropical fish and goldfish should not be put together in an aquarium as tropical fish often kill the goldfish. Also the fighting paradise fish must be kept away from other tropical fish.

Some wild fish will survive in an aquarium and they make in-

teresting pets. Small sunfish, bluegills, and bullheads are examples.

Snails should be put into the aquarium to act as scavengers. They help keep the sides of the aquarium clean. Tadpoles will serve the same purpose. Clams also help keep the water clean. If water turtles and small frogs are put into an aquarium, they should be provided with flat pieces of wood onto which they can crawl and get out of the water for air.

The first rule in the feeding of fish is not to overfeed. Only a small amount of food should be given, or as much as will be consumed at that feeding. Food not eaten at once falls to the bottom of the container, sours, and makes the water impure. Goldfish can be fed as seldom as once a week. They should not be fed more than three times a week. Tropical fish should be fed three times weekly.

Oatmeal (cooked), boiled white of egg, cream of wheat (cooked), liver (cooked), beef (cooked or raw), chopped earthworms, and flies are good food for both goldfish and tropicals. These foods are better than artificial food. If wild fish are used, the children should find out about the natural food of these fish and supply it as nearly as possible. Wild fish can usually be fed on earthworms and chopped raw beef. They will also eat live insects placed on the surface of the water.

If the aquarium is balanced, the animals and plants will look healthy and the water will be clear. Cloudy or milky water is probably due to the spoiling of uneaten food, or to decaying plants. This water is bad for fish. Immediately remove the fish and clean the aquarium and replenish with fresh water. In changing fish from one container to another, keep water temperatures the same. Fish cannot stand sudden changes of temperature. Be sure also that tap water has been properly conditioned to remove chlorine.

Fish should be handled with a small net or lifted out in a dish of water. Grasping them with the hands is likely to break the film over the scales and permit fungus to get started. If a fish is diseased, remove it at once and put it into a solution of salt water, in proportions of one teaspoon of salt to a quart of water. It may remain in the solution for a period of several hours. Then put it

into a container of fresh water. Repeat the treatment every day until the fish is well.

The children will get much pleasure and profit from their management of both terraria and aquaria. There are many interesting aquarium books and magazines on the market to which they can turn for lists of animals and plants and for notes on feeding. Also in recent years there has been much interest in amateur tropical fish raising and many of the children may come from homes where there is a tropical fish enthusiast.

HOW TO CARE FOR CATERPILLARS

Some caterpillars spin cocoons, some form chrysalids, some go into the ground to pupate, some spend the winter hibernating in the larval stage. In discussing them with the children, suggest that since the caterpillars they find may not be ready to pupate, they must be sure to bring in some of the leaves on which they find the larvae. Then you will know what to feed them. Caterpillars will leave food and hunt a suitable place when they are ready to pupate. Polyphemus caterpillars may be put into a glass jar that has some twigs with leaves on them. A piece of glass may be laid over the top of the jar. This prevents escape of the caterpillar and also helps keep the leaves fresh. If the caterpillar is still hungry it will eat the leaves. The jar should be cleaned each day and fresh leaves put into it. When the caterpillar is ready to spin, it will use the twigs and sides of the jar as its foundation and spin leaves into its cocoon. When the cocoon is finished, it may be removed from the jar and put into a cool place until spring. Jar and all may be put away. If it is kept in a dry place, the cocoon should be dipped in water once in a while.

Caterpillars like the tomato sphinx (tomato worm) go into the ground to pupate. There should be some garden soil in the bottom of the jar for them. A flower pot with a cylinder of wire screening over it is good, also. Some Woolly Bears hibernate in the larval stage so a terrarium with some dead leaves and pieces of bark makes a good home for them. They will spin in the spring. Some Woolly Bears spin in the autumn.

The Monarch or milkweed caterpillar forms a chrysalis. If the children bring any Monarch caterpillars in, put them into a jar

with milkweed leaves. When ready to pupate, they will spin pads of silk on the underside of a jar lid, leaf, or twig, then hang from it and shed the larva skin, leaving the green chrysalis. Since the caterpillars that form chrysalids in the autumn soon emerge, they may be left in the room for the children to watch. Chrysalids of butterflies that emerge in the spring may be cared for in the same way as the cocoons.

Fruit and salad dressing jars are just as good as more elaborate equipment. The main things to keep in mind are to have fresh leaves of the right kind which are kept from drying too quickly but are not wet, and not to have too much heat. After pupae are formed, they should be placed in a cool place, not moist enough to mold, but not dry enough to kill the pupae. Cleanliness in their care is important, as many caterpillars are susceptible to disease. Also when handling caterpillars, be careful not to bruise them. It is better to let them crawl onto a twig and then move the twig, than to pick them up with your hands.

OTHER ANIMALS IN THE SCIENCE ROOM

The extent to which it may be desirable to keep animals in a schoolroom depends upon the size and facilities of the room, the interests of the children, and the kinds of animals you wish to keep. While some plants and animals if properly cared for are sure to make a room more interesting, we mustn't lost sight of the fact that the children are the most important occupants of the room. If having other animals makes the room less attractive or comfortable for the children, you should either do without the other animals, or choose animals that are easily kept in captivity and cared for.

Directions for the care of aquarium and terrarium animals have already been given. All these cold-blooded animals are clean in their habits and have little or no odor about them.

Small mammals such as rats, mice, guinea pigs, and rabbits may be kept in cages in the room if the cages are kept clean. Cages with removable metal bottoms are more easily cleaned than wooden ones. A cage may be made of an orange crate with a galvanized iron tray made to slide in the bottom of the box. One-

Observing a turtle.

half-inch mesh galvanized wire should be fastened to the open side and a sheltered corner should be made of a smaller box which is placed inside the cage. All animals need to have a place in which to hide.

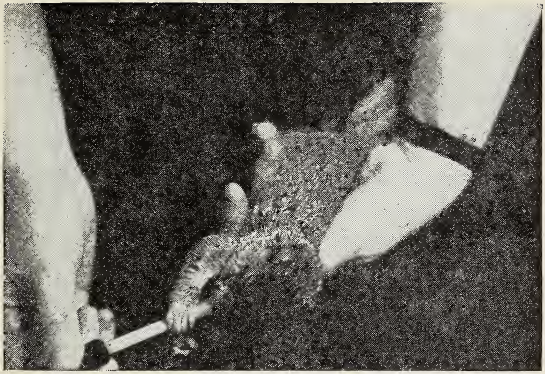
Sawdust or straw should cover the floor of the cage and be replaced with fresh material every day. If a layer of newspaper is put on the floor first, the cage can be more easily cleaned. The animal will carry some of the nesting material into its sheltered corner for a bed.

Guinea pigs and white rats are more easily kept in a schoolroom than rabbits. Rabbits may be brought in for a day or two, but it is better for them to live out of doors.

These rodents may be fed oats, alfalfa hay, carrots, and other vegetables. The young ones should have milk and a few drops of cod liver oil each day during the time when they do not get plenty of sunshine.

If the schoolroom is closed and becomes either very hot or cold over the week-ends, the animals should be taken to the home of one of the children. Extremes of temperature are not good for warm-blooded animals, particularly when in captivity where they can't protect themselves.

Although many of these animals are able to get their water from



Feeding a young squirrel.

their food, water should always be provided in the cages. The container should be low enough for the animal to drink from and of a kind not easily tipped over.

Wild rodents, such as meadow mice, squirrels, and chipmunks are sometimes brought into the schoolroom. Adult wild animals are difficult to tame and often refuse to eat. Young wild rodents, however, may be cared for and make interesting pets. If they are very young they may be fed on warm, diluted condensed milk. The smaller the animal the more warm water should be added to the milk, the more frequently it should be fed, and the less it should have at each feeding. One needs to use common sense in caring for these young animals. Keep them warm, let them alone as much as possible, and don't overfeed them.

Children sometimes bring other young mammals to school. Until the animal is old enough to eat solid food, its care is the same as for the other animals mentioned above. Teachers may find detailed directions for rearing all kinds of wild animals in Moore's *Wild Pets.* See reference list.

Young birds are easily reared if you know the food to give them. Any good bird book will tell the food of the common species of birds. Insect-eating birds may be fed earthworms, caterpillars, and small larvae of beetles. Hard-boiled eggs may be substituted

for part of their food. The shells should be crushed and fed with the egg. Young flickers may be fed on raw eggs and ants.

Seed-eating birds may be fed any kind of small seeds. Chick-feed is easily obtained. Some bread may be given them but should be supplemented with seeds. All birds need sand and other hard foods.

When a bird is first found it may have to be fed forcibly. Open its beak gently and put the food in the back of its throat. A pair of forceps or tweezers is useful in accomplishing this. The bird won't swallow unless the food touches the swallowing center on the back of its tongue.

Fish-eating birds such as bitterns and loons are occasionally found and brought to school. These are problems to feed as they do not thrive on dead fish. The author has successfully fed young fish-eating birds on live tadpoles and minnows.

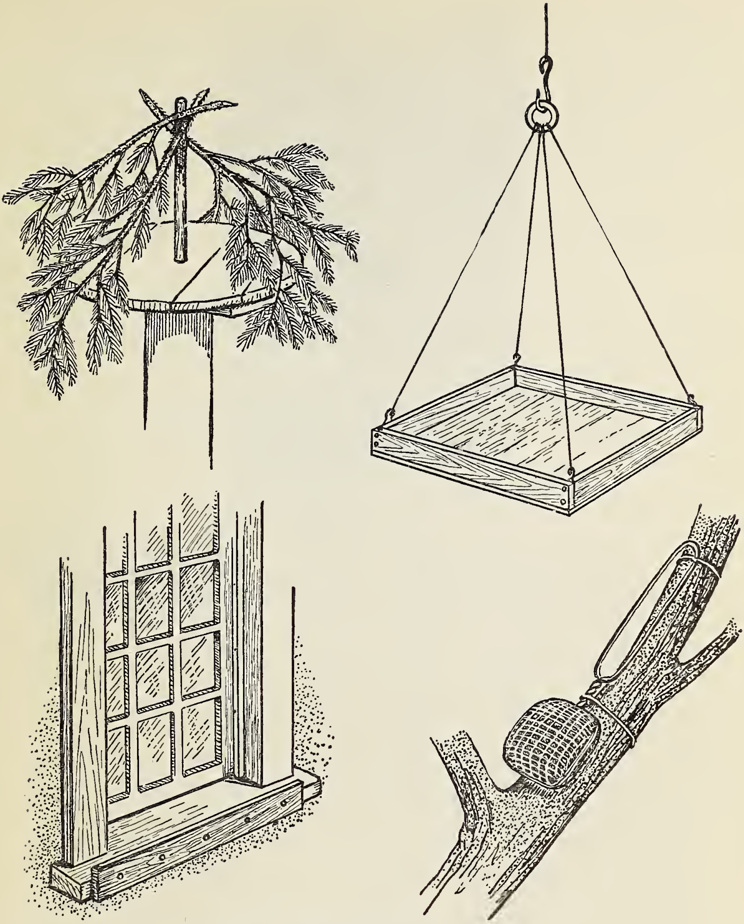
Hawks and owls may be fed pieces of meat which have been wrapped in cotton or rolled in sand. These birds should be handled with care as their bite is painful. Young ones soon learn where their food is coming from and open their mouths.

Unless a wild animal is too young to care for itself, it is wise to keep it awhile for study and then release it. School buildings are not built to house the lower animals. A trip to a well-run zoo will demonstrate how varied are the needs of the different groups of animals. It would be impossible to duplicate these conditions in a room where children live. A cage built outside a window on a level with the window sill will partially solve the problem. If a squirrel or rabbit is to be kept for any length of time this might be worth while.

In caring for any animal, the children should be made to feel responsible. They should read about the natural habitat and food of the animal and try as nearly as possible to duplicate these conditions. Even though some animals die, the value to the children makes caring for them worth while.

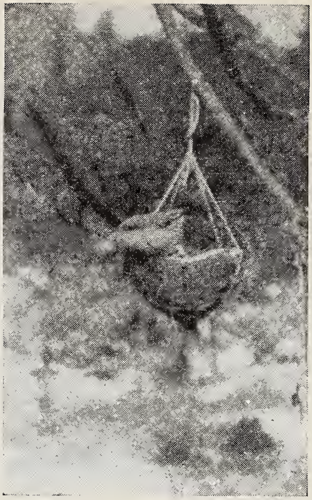
WINTER BIRD FEEDING

In the northern part of the United States most of the common birds migrate in the autumn but there are a few that remain through the winter. Why birds migrate is a question no one has



Simple feeding stations for birds.

solved satisfactorily, although there has been much written on the subject. The teacher should familiarize herself with the theories of migration and not try to solve the problem.



Half a coconut may be filled with melted fat.

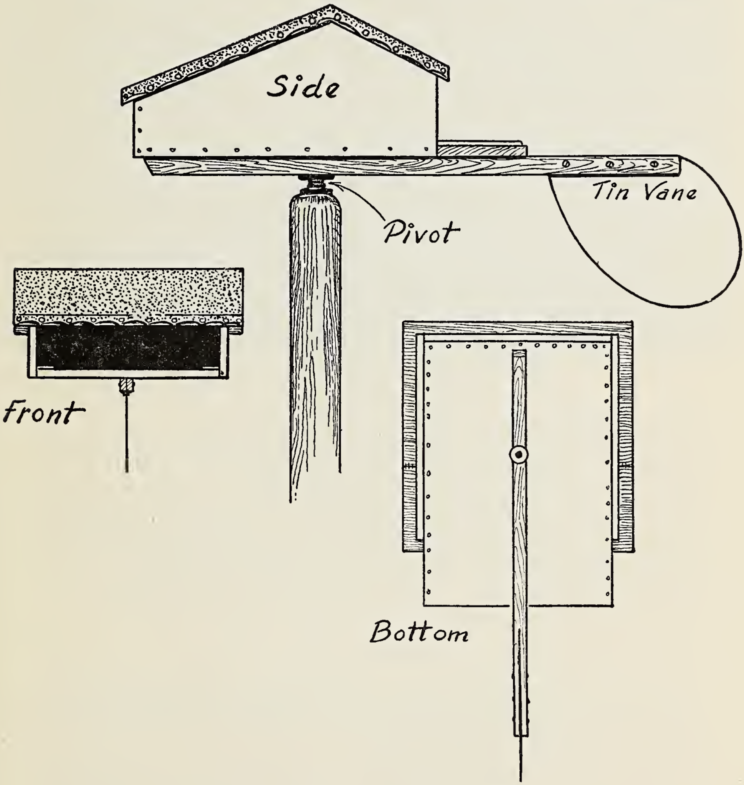
Some winter bird residents stay the year around in the north. Among these are the chickadees, nuthatches, and downy woodpeckers. Others come from farther north, spend the winter, and return to their northern nesting grounds in the spring. Brown creepers, juncoes, and tree sparrows are examples of these.

Some winter birds are insect-eaters and some feed on seeds or fruit. The downy woodpecker is able to chisel through the bark of a tree and with its tongue spear the larvae underneath. Nuthatches and brown creepers get insect eggs and insects from the crevices in the bark. Chickadees and titmice find their insect food mostly in the buds and on the twigs of shrubs or trees. But in winter, all of these will eat whatever they can find. Since they are meat-eaters, we put suet or nuts on the feeding shelf for them. To prevent suet from being carried away by a blue jay or starling, it may be put into a wire basket made of coarse screening.

A soap shaker may be filled with suet and hung from a wire. The suet may be tacked to a tree or tied to a limb. The nuts

should be crushed or finely cracked to prevent squirrels from carrying them away. Birds will scratch among the shells and pick up the bits of nut meats. Walnuts or hickory nuts are good bird food, and may be gathered by the children in the autumn, to save for winter feeding. Half a coconut may be filled with melted fat and hung from a branch. Cracked nuts or seeds may be added to the fat.

Juncoes, sparrows, goldfinches, and cardinals are seed-eaters.



A more elaborate feeding station.

Any seeds, such as wheat, oats, millet, or cracked corn, will attract them. Sweepings from a mill are welcomed by birds and they will scratch in the chaff for days, finding tidbits. Cardinals and grosbeaks are especially fond of sunflower seeds. Crumbs of any kind will attract birds, as will berries and pieces of other fruits. The children can put out discarded apple cores and cranberries. Breakfast food or other cereals which might be discarded because of weevils are good bird food. Even weed seeds are attractive to birds.

Shrubs with berries on them always attract birds. Among these are snowberry, barberry, high-bush cranberry, wild plum or cherry, and bush honeysuckle. Teachers who have anything to do with landscaping the school grounds should see that some such shrubs are planted.

A simple shelf is as effective as a more elaborate one. Just an extension from the window will work, although a roof prevents snow from covering the food. The birds may not come at first, so a good way to get them started is to sprinkle some grain on the ground under the shelf. The sparrows will come first and though we do not care so much for them, they show the other birds the way. A dry doughnut dangling at the end of a string will provide entertainment equal to circus acrobats.

A swinging shelf usually frightens sparrows and drives them away. However, for teaching purposes in the primary grades even an English sparrow has possibilities. It is surprising how many adults do not really know English sparrows.

In snowy, freezing weather, water is as hard for birds to get as is food, so water should be put out for them each day. It will often attract birds not attracted by food. A shallow earthenware container like the saucer of a flower pot is good for this purpose.

FIELD TRIPS

If properly conducted, a field trip may be an important activity to help in the solving of some science problem. Improperly conducted, it may be a waste of time.

A field trip must have purpose. It must come as a result of a need to learn something outside the schoolroom. It need not mean

A field trip—looking for birds' nests.

a long trip. For example, in a discussion of soil formation the question may arise of whether freezing and thawing break up rock and form soil. To illustrate this, the children may go outdoors and find rocks that have been cracked in this way. Even sidewalks and the foundations of buildings illustrate the point.

The teacher should anticipate any trip she plans and make the trip herself before she takes the children. If she intends taking the children to see birds, she should make sure that there will be birds to see. Birds are elusive and cannot be tagged and made to stay in one place. But a nest that is being built, or the work of a woodpecker located by the teacher or some member of the class, will remain until the whole class sees it. With a definite objective in mind, the teacher is sure to prevent disappointment and aimless looking.

Before starting on a trip, the teacher must be sure that every

A field trip—locating territories of birds.

child knows what he is going to look for. There is endless variety in the number of interesting things to see out of doors, but unless the attention is directed to a few, there will be confusion, and no learning will result.

For example, on the way to a river to see erosion, the group may watch for terraces that have been made as the river cut down to its present bed.

A large group should be organized into small units with a leader for each. These may be working on the same problem or different problems. If unusual things are found, the whole group may be called together to see them.

A simple way to organize groups is to make enough slips of paper for each member of the class. Number them from one to five. Circle one one, one two, one three, one four, and one five.

After a field trip—rock study.

Have the children draw slips. All the ones make a group. All the twos make a group, and so on. The children with the circled numbers are the leaders for the day.

Children like to make their own rules for field trips and take pride in following them. Here is a set of rules made by a third-grade class before going on a trip to study birds.

1. Walk quietly. No loud talking.
2. Follow your leader.
3. When you see a bird, stop. When the leader stops, everyone stops.
4. When you see a bird and want to show it to the rest of the group, tell them where it is without pointing. (Birds see better than they hear and are startled by quick motions.)
5. When you are looking at a bird, stand with your back to the sun.

Too many rules are confusing just as too many directions are. It is better to take short trips at first, trying out one rule; then add more rules as longer trips are taken. If the children understand what the trips are for, they will gain the proper attitudes toward them.

It is very important in any science work to respect the discoveries and ideas of children. When they see or find things on a trip, the group should give as serious attention to them as to the teacher's contributions. This encourages children to observe and it intensifies their interest.

On a collecting trip, enough containers should be taken along to carry back any specimens. Directions on how to collect and what to collect should be clearly understood before leaving the school. Collecting should be done only when material collected is to be used. If such material may be studied to better advantage in the schoolroom than out of doors, it serves a purpose. But only as much as is needed should be taken. Gathering hundreds of frogs' eggs would be wasteful when a few would be all the children could care for. It is better to raise a few tadpoles to adulthood than to have dozens die for lack of room or food.

Some of the types of trips may be listed as follows:

1. A trip to locate territories of birds. Return at regular intervals to watch nest building and rearing of young.
2. A trip to collect rocks.
3. A trip to see types of erosion.
4. A trip to find tracks of animals.
5. A trip to find and collect galls.
6. A trip to a zoo or museum to see something that has been discussed in class, such as fossils.
7. A trip to a meadow to collect weed seeds.
8. A trip to observe the sky.

The suggestions for teachers in connection with the stories list other ways to give purpose and variety to field trips. Trips should never grow so common or become so regular as to be monotonous, nor so dull as to be meaningless. Children should always regard them with enthusiasm, not because they offer an opportunity for play, but because they are the most satisfying solution to many of their science problems.

THE HOW AND WHY SCIENCE BOOKS

BASIS FOR CHOICE OF MATERIAL

CHILDREN'S INTERESTS

Children's interests were closely studied in preparing and organizing the material used in THE HOW AND WHY SCIENCE BOOKS. The subject matter was used by the authors in actual teaching experiences over a period of several years and with many different age groups of children. The problems were used in mimeographed form until arranged for publication.

RECENT COURSES OF STUDY

The material for the books was originally chosen from units that appeared in many courses of study from many sections of the United States. City and state courses of study were consulted, as well as those prepared and used in teacher-training institutions. More recent studies, problems which have arisen in the classes of the authors, and new courses of study have added new material to the original series.

The outlines for science in the elementary grades found in the *Thirty-First Yearbook* and in the *Forty-Sixth Yearbook* of the National Society for the Study of Education have been closely followed. Some quotations from the *Forty-Sixth Yearbook* are of interest here:

"Instruction in science should begin as early as children enter school; activities involving science should be provided even in the pre-school and the kindergarten. Through the sixth grade the work in elementary science should consist of a continuous integrated program of the sort advocated by the *Thirty-First Yearbook*. Such a program should provide an expanding, spiral development of understandings, attitudes, and skills, as prescribed in chapter iii."—pp. 41–42

"It is most important that the material selected for each grade of the primary school be balanced to include the elements of learning which represent a rich experience with science. Each level should give the child some opportunity for exploration with content derived from the great major fields of science: astronomy, biology, geology, and physics. This cannot be accomplished by studying only plants and animals.

"There should also be balanced instruction as to the types of activities employed. Children should have a rich opportunity to develop their abilities in discussion, in experimentation, in observing in the out of doors, and in reading for information and motivation. A complete program of instruction in primary science can be maintained only by the full utilization of all these activities, for each plays its part in the development of the purposes of science education."—p. 84

"Since experimentation involves 'learning by doing,' there can be no substitute for it. Pupil experimentation is an essential part of science education. In every course of science offered at any level, therefore, opportunities should be provided for pupils to perform experiments." —p. 53

"The basic purpose of the elementary school is the development of desirable social behavior. Science, with its dynamic aspects, its insistence upon critical-mindedness and better understanding of the world, and its demand for intelligent planning, has a large contribution to make to the content and method of elementary education.

"To accomplish this basic purpose a continuous program of science instruction should be developed throughout public school education, based upon a recognition of the large ideas and basic principles of science and the elements of the scientific method. Children must be given opportunity to gain the knowledge necessary for intelligent and

cooperative experience with the world of matter, energy, and living things and to develop constructive appreciations, attitudes, and interests. This demands that the individuals in our society become intelligent with reference to the place of science in individual and social life.

"When the content and method of science are examined, it is found that the child's normal activities have much in common with the purposes of science in modern society and that the teacher can view the teaching of science as utilizing the natural dynamic drives and potentialities of children."—p. 73

"Work in the primary grades should not be exhaustive. Rather the child should feel that there is more to learn about everything that he does. A developmental point of view demands that a well-balanced program provide contacts with realities. It cannot allow omissions in the development of the concepts, principles, attitudes, appreciations, and interests derived from the field of science."—p. 82

"The new program of science, which emphasizes the development of desirable social behavior, is organized around problems that have social value and are challenging and worth while to children. The teacher must, therefore, look back of the objects of the universe to the problems which involve meanings that the children will need to understand in order to participate intelligently in life. This means that, in science, opportunities must be provided for the development of understandings in all the areas of the environment and at all levels of social needs."—p. 92

HEALTH, SAFETY, CONSERVATION, AND AERONAUTICS AS INTEGRAL PARTS OF A SCIENCE PROGRAM

The authors of The How and Why Science Series have made health, safety, conservation, and aeronautics integral parts of the science program. This is in accordance with the recommendations of the *Forty-Sixth Yearbook*:

"*What is the place in the science curriculum of conservation, aeronautics, physiology, and health education?* The materials of these areas are of value chiefly for general education. Except, perhaps, for an eighth-grade one-semester course in health and physiology, it is probably not desirable to offer separate courses in any of these subjects. Their materials can be more effectively integrated with those of the regular courses of the science sequence and with other courses in the program of studies."—p. 46

"The content of the science program in many elementary schools is now being organized around problems which have social value and which are significant in the lives of children. These problems arise from children's

interest in the world around them and from their need to meet intelligently their problems of living in areas such as health, conservation, and safety. They are solved not through the mere accumulation of facts but in such a way as to help children (1) develop meanings which are essential to social understanding, and (2) put into practice desirable social behavior. Problems involve meanings in their solution, and meanings are learned through experiences."—pp. 69–70

"A program in science should develop a large background for the teaching of health. Many schools are now integrating health entirely with science and the social studies. Science provides much of the background for the teaching of health facts and the development of health habits. Moreover, in their study of science, pupils should gain a vision of the potentialities of science in the improvement of the health of the nation and the world."—p. 76

"Likewise, science is involved in accident prevention and safety instruction. We cannot fully anticipate the environment of the future. New inventions may eliminate present hazards and create new ones, making it impossible to develop a code of conduct in safety instruction which will be functional for an entire life span. It may be well, then, in safety instruction to place more emphasis upon the scientific principles which are basic to safe conduct."—p. 77

"The place of science in bringing about the wise utilization of natural resources to the welfare of mankind is an important aspect of the science areas related to the social needs."—p. 77

Health lessons throughout The How and Why Science Books are not labeled as such but take their places naturally as a part of the science program. They are taught also by implication in the illustrations. If health concepts are included in a science book, children learn to assume a scientific attitude concerning health problems. Many science problems are also health problems. The use of the thermometer is taught in science, and it has many implications for health. The germ theories of disease, contagion, and quarantine are all science subjects that are important in health.

Safety is taught both in connection with health and as a part of scientific procedure.

Many activities in science may contribute to the goal of conservation education. Appreciation of the natural and physical world (one of the objectives of all science teaching) should lead

to conservation of wild life and other natural resources. Throughout the books of The How and Why Science Series are such stories as "We Need Soil," "Insect Catchers," "Plants Depend on Animals," "Animals Depend on Plants," "Use—Don't Waste." As in the case of the health and safety lessons, the conservation material takes its place naturally as a part of the science program.

Although World War II gave an added importance to the subject of aeronautics, and a considerable number of separate courses in this field are being taught, chiefly in the senior high school, the authors of The How and Why Science Series believe that this subject can be more effectively integrated with the regular science course. Beginning in the Pre-Primer, the books of the series provide valuable and adequate instruction about the science of flight. Again, this material takes its place as a part of the science program in the study of air and its properties.

THE PLAN OF THE PRIMARY SERIES

SCIENCE THROUGH STORIES AND PICTURES

The books of The How and Why Science Series have a wide scope, including the fields of natural science, physical science, and human science.

The plan of the primary books is to tell stories dealing with the interpretation of natural phenomena common to the experience of children. Science is just as exciting as any other body of subject matter if told in a way that appeals to children. However, the restricted vocabulary of the early grades is often a handicap in presenting what are really simple science concepts. Such concepts can be taught effectively by pictures. In fact, before children can read the words, they enjoy looking at the pictures, and may learn science concepts from them. The books of The How and Why Science Series are beautifully and effectively illustrated. The pictures are reproduced from original water-color paintings by a method so faithful in its reproduction that the illustrations in the books seem themselves to be original paintings.

Nowhere is there a better expression of what appeals to children in the way of books than in the opening chapter of *Alice in Wonderland*:

> "Alice was beginning to get very tired of sitting by her sister on the bank, and of having nothing to do. Once or twice she had peeped into the book her sister was reading, but it had no pictures or conversation in it, and 'What is the use of a book,' thought Alice, 'without pictures or conversation?' "

The books of The How and Why Science Series have *pictures* and *conversation.* The pictures are accurate and beautiful. The conversation is natural and interesting.

THE ORGANIZATION OF MATERIAL

The early books of the series are organized seasonally although the units may be taught at any time. Biological units to be natural have to be seasonal.

Most scientific principles are too difficult for little children to understand. But they can understand concepts which may grow from year to year until finally they can be put together to make a principle. For example, the principle that living things have certain modifications of structure which make it possible for them to survive is too difficult for first-graders. But they can observe that animals are doing different things in autumn, winter, and spring. In the second grade they learn more about these animals such as ways in which they survive the winter by hibernating, pupating, and migrating. In the third grade they enlarge the idea to include ways these animals are protected so that they do survive, such as fur, scales, and feathers. Thus as children are able to comprehend larger concepts, they gain them. Eventually they will be able to derive the principle that animals have survived through the ages because of modifications in their bodies that make it possible for them to live in the environments in which they find themselves.

Because the authors believe in the problem-solving method of teaching, the material in the outlines is organized in the form of problems. If the teacher keeps these problems in mind as she teaches, purpose will be given to her work.

ILLUSTRATIVE MATERIAL

Environment and individual differences play such an important part in children's science interests that the teacher must be guided by her own group in the choice of problems. Some problems may have to be teacher-motivated because lack of experience on the

part of her group may mean that the children will not initiate them. Once introduced to the material, children should accept it with interest, otherwise it is not suitable for them.

The teacher who has had little science experience will find help in knowing what may interest her group from the suggestions given in this and other Manuals for the series, but *she should always be ready to follow child-initiated activities when they arise.* She should not be like the teacher who, having planned a lesson on buds, was disturbed when Johnny brought in a turtle. "Take it right back," she said. "Today we are studying buds."

Illustrative material should come primarily from the child's own environment, but not exclusively so. In this regard the *Thirty-First Yearbook,* page 148, states:

> "Some have contended that no illustrative material should be used except that which is in the natural environment of the school. This seems to be a very narrow interpretation of illustrative material. In this day when the child listens to the events happening in Antarctica, or other far parts of the earth, in which his environment is spreading out so that the whole world comes into his own home in one way or another, to restrict the illustrative material to local, indigenous objects seems, indeed, to be inexcusable."

The subject matter of The How and Why Science Series has been arranged to appeal to as many different groups as possible. Biological units have been chosen in such a way that different sections of the United States are represented. Illustrative material is taken from the East, the West, the Middle States, and the South, thus broadening the scientific concepts acquired by the children using these books.

VOCABULARY TREATMENT

Background of experience and facility in the use of oral expression are prerequisites to the understanding of printed material but are not the sole factors involved in reading that material. Word pronunciation and mastery are factors of equal importance.

To this end, the authors of the primary books of The How and Why Science Series have constantly kept in mind the problems of vocabulary mastery. Each new word has been checked against the Stone and the Gates standardized lists of vocabulary for the primary grades to determine the level at which the word should

be used. Adequate and consistent growth in expansion of the child's vocabulary, level by level, has been carefully and scientifically planned.

Each sentence in the books has been analyzed with readability in mind. Length of sentence, sentence structure, difficult words, as well as the nature of the concepts involved have been used as criteria for checking readability.

As a teaching aid, a list of new words for each book is given in the back of that book, with an explanation of the writers' plan in the introduction, repetition, and use of these words.

Using the latest research on the problem as a guide, the mechanical aspects of the reading have been as carefully worked out in this series as in any basic reading program.

THE COMPANION BOOKS

There is a Companion Book designed to accompany each of the texts. The objectives of each of the primary Companion Books are to:

1. Extend and enrich certain concepts
2. Develop a scientific way of thinking
3. Promote language growth

To arrive at these objectives the following activities have been planned: coloring (governed by knowledge of concept), cutting, pasting, and freehand drawing; matching of ideas; selecting and evaluating ideas; placing ideas in proper sequence; reading statements and matching them with pictures; reading simple problems and solving them; doing simple experiments and recording data by pictures or other means on their level; doing simple tests of concepts learned.

Most of the activities in the primary Companion Books are ones that primary children can do alone. However, there are a few that will require a little thought on the part of the teacher, and at least some discussion. The authors are convinced that as the children acquire more skills, new learning should take place—that the Companion Books should not be just testing programs but an application of principles and concepts to new situations; that the lessons should require the using of skills which are necessary in

gathering scientific data and solving problems to attack problems similar to those the children have read about in the text.

FILMSTRIPS

A number of filmstrips have been prepared to correlate with the books of The How and Why Science Series. These extend and enrich certain concepts presented in the books, and enable the teacher to achieve her objectives more easily, quickly, and successfully.

The filmstrips have been prepared in series, with three strips in each series—on primary, intermediate, and upper-grade levels. For example, in the series on Weather, Filmstrip #1 ("We Learn about Weather") is designed for the primary grades; Filmstrip #2 ("Changes in Weather") is designed for the intermediate grades; and Filmstrip #3 ("Understanding Weather Conditions") is designed for upper grades. The strips are available singly or in series. Further information about them will be sent upon request.

AN OUTLINE SHOWING THE DEVELOPMENT OF CONCEPTS

Although each Teacher's Manual contains a detailed outline for a year's work, it may be helpful here to show in chart form the plan and organization of the entire primary group of The How and Why Science Series.

In an effort to accomplish this purpose, the chart on the next two pages is presented. It is a master chart to show the organization of all five books. An examination of this chart will show that the entire field of elementary science is divided into three main content areas—those of Living Things, Physical Environment, and Health. The horizontal divisions show how the concepts grow from book to book and contribute to principles in the upper grades. Vertically, each column represents in brief the science program presented in a single book.

A large, more detailed chart is published separately. In this separate chart the horizontal development shows in more detail the growth of the concepts, and the vertical columns present more elaborate outlines of the material covered in each book. This separate chart may be secured upon request.

ORGANIZATION OF THE ELEMENTARY SCIENCE PROGRAM IN THE HOW

Content Areas	*We See—Pre-primer*	*Sunshine and Rain—Primer*
LIVING THINGS ANIMALS (*See also detailed chart published separately*) In *WE SEE* these concepts are developed by means of pictures.	There are different kinds of animals. Animals are alive. Some animals will need to be fed in winter. Squirrels, ducks, and turtles all have young. Animals eat many kinds of food. Animals go through changes as they grow.	Animals are affected by the seasons. 1. Animal activities in autumn. 2. Animal activities in winter. 3. People get ready for winter. Animals live in different places, differ in structure, and eat different kinds of food. Animals make tracks in snow or mud by which we can follow them.
PLANTS (*See also detailed chart published separately*)	Plants are alive. Seeds grow when planted. Plants have life cycles. Plants are affected by the seasons—autumn, winter, spring, and summer.	There are different kinds of plants. Plants grow in different places. Plants are affected by the seasons. 1. Trees in autumn. 2. Trees in winter. 3. Trees in spring. 4. Trees in summer.
THE BALANCE OF NATURE (*See also detailed chart published separately*)		Children can make simple homes for animals.
PHYSICAL ENVIRONMENT WEATHER AND SEASONS (*See also detailed chart published separately*)	The earth is made up of land, water, and air. We have day and night. There are different kinds of days. We have four seasons. The change of seasons affects animals, plants, weather, and length of day and night. Air is all around us. We see rainbows in the sky. We see rainbow colors in water.	The land, water, and air are farther away than we can see. We travel on land and water and in the air. Rain, fog, and snow are water. Water has different forms. Length of day and night changes.
THE SKY (*See also detailed chart published separately*)	The sun shines on the earth and makes day. We can see the moon and stars in the sky at night. We are in the earth's shadow at night.	Light from the sun makes us warm. Light from the moon and stars helps you see at night. Sunlight helps things grow.
EARTH STUDY (*See also detailed chart published separately*)	The earth is large. The earth is land, water, and air. Seeds are planted in soil. Air is all around us.	The earth is very, very large. People, other animals, and plants live on the earth. We can travel over the earth.
FORMS OF ENERGY (*See also detailed chart published separately*)	We use electricity in our homes. A magnet pulls some things.	The sun gives us heat.
SOUND (*See also detailed chart published separately*)		
BUOYANCY (*See also detailed chart published separately*)	Boats float on water.	Boats float on water. Kites float in the air.
MACHINES (*See also detailed chart published separately*)	We use machines in our home. Machines make work easier.	A windmill is a machine. Windmills do work.
HEALTH GROWTH CLOTHING BODY—PARTS AND FUNCTIONS CLEANLINESS FOOD POSTURE EXERCISE AND PLAY SLEEP AND REST COMMUNICABLE DISEASES SAFETY REPRODUCTION OF LIFE	Plants and animals need food and air to grow. Wear seasonal clothing. Keep your body clean. Eat the right food. Play out of doors. Cross streets carefully. Do not play in the street. Animals and plants make others like themselves.	All living things need food and air to grow. Seasonal clothing. Ready for school. Good foods. Ways of storing food for winter. Seasonal play. Colds are communicable. Children with colds should stay at home. Going to school. Butterflies reproduce. Bulbs make new plants.

AND WHY SCIENCE SERIES, PRE-PRIMER THROUGH THIRD GRADE

Through the Year—Book I	*Winter Comes and Goes—Book II*	*The Seasons Pass—Book III*
Robins, chickens, moths, butterflies, toads, and mammals all have young. Animals grow and develop. Animals eat different kinds of food and live in different kinds of places. Animals are affected by the seasons. 1. Animal activities in the spring.	Animals are able to survive the changing seasons. 1. Insects 6. Reptiles 2. Spiders 7. Crayfish 3. Fish 8. Mammals 4. Birds 9. Earthworms 5. Amphibians Animal tracks may tell a story.	Animals are protected in many ways. 1. Some animals migrate. 2. Some animals hibernate. 3. Birds care for their young. 4. Some animals are protected by their structure. 5. People help protect birds and pets. 6. People are protected by clothing and shelter. 7. Each animal is fitted to the kind of place in which it lives.
Plants are affected by the seasons. 1. Plants in spring. 2. The bean cycle.	Plants are able to survive the changing seasons. 1. Trees are plants. 2. Seeds are scattered in many ways. 3. Bulbs have stored food which helps them to grow. 4. How seeds grow. 5. How wild flowers survive.	Plants are protected in many ways. 1. Some trees lose leaves and have winter buds. 2. Plants produce new plants in different ways. 3. Plants need soil and water. 4. People help protect wild flowers. 5. Plants need a favorable climate.
A home for water animals.	How to make terraria for caterpillars and spiders. How to make an aquarium.	How to make a terrarium for snails. Aquarium vs. terrarium.
Rivers are enlarged in spring. Heat makes water go into the air. Rain comes from clouds. A thermometer shows how hot or cold the weather is. Wind is air that is moving. Weather changes. Rainbows are made when the sun shines on rain. Rainbow colors may be seen in several places. Fire needs air to burn. The wind, sun, and water affect rocks.	Weather changes. Weather in many places. We read a thermometer above or below zero. Water 1. Evaporation and condensation. 2. Different forms. 3. Effect of lack of water. How clouds are made. Animals and fire need air. The weather vane tells what kind of wind is blowing.	Day and night are caused by the rotation of the earth. Thermometers have many uses. Rainbows 1. Sunlight makes rainbows. 2. Sunlight has all colors in it. Air 1. Air takes up space. 2. Air has pressure. 3. Air expands when heated.
The sun gives heat and light. Colors are in the sunlight. The sun and stars are always shining. Stars are far away. Stars make pictures in the sky. We can tell directions by the sun and stars.	The moon seems to change in size and shape. Star pictures—Big and Little Dippers, Orion, Milky Way The North Star is part of the Little Dipper. The North Star helps us tell directions.	The causes of the moon phases. Constellations—Cassiopeia Dippers Orion Relative sizes of sun, earth, and moon. The needle of a compass points north. A compass helps us tell directions.
Rivers and mountains are part of the earth's surface. We put soil into an aquarium. Seeds need good soil to grow. There are different kinds of rocks.	Tree roots are in soil. Some things dissolve. Some do not. Some things form crystals. Soil holds water that plants use. Caves are made in the earth. The earth is round like a ball. The earth has gravity.	How trees use water from the soil. How soil is made. There are different kinds of soil. How soil is carried. Fossils. Different kinds of rocks have different names.
The wind helps things fly. A magnet will pull things made of iron. Electricity makes some things move.	The sun helps living things grow. The wind does work. A magnet has N and S ends. Electricity makes heat and light.	Heat breaks up rocks. The wind does work. Air pressure can be made to work for us. Lightning is electricity.
		Our ears help us hear sound. A thing must vibrate to make sound.
Some things float. Some things do not float.	Boats float.	
An engine is a machine. Engines do work.	Windmills do work for us. A seesaw does work. Engines help move airplanes. Wheels make work easier.	Levers make work easier.
Living things must have proper care to grow. Proper clothing protects our health. We breathe through our noses. Wash hands to get rid of germs. Germs may make one sick. Cleanliness with food at the seashore. Indoor and outdoor play. Rest after play. Early to bed. Robins, chickens, rabbits, toads, butterflies, moths, and mammals all have young that grow up to be like their parents.	Sunshine helps plants and animals to grow. Seasonal clothing. Care of teeth. Soap and water for cleanliness. What to eat. How to eat. How to stand and sit erect. Play out of doors. How to put out a fire. Insects, plants, amphibians, reptiles, crayfish, squirrels, and birds all have young.	Our bodies need good food, fresh air, and sunshine. Wool, cotton, silk. Eyes, ears, nose, mouth, teeth, skin. Care of skin. Milk and vegetables. Value of good posture. Vacation fun. 8 o'clock for eight-year-olds. Quarantine. How to cross a street. Insects and birds lay eggs. Young mammals are born alive.

SUNSHINE AND RAIN —A PRIMER IN SCIENCE

THE PLAN OF THE BOOK

Sunshine and Rain is designed to answer many science questions children ordinarily ask during their first year of school life. The problems set up in the outline are common ones that arise in the kindergarten and first grade. They may not arise in one year, and there may be other questions that will be asked by individual groups.

The time required to teach the material in the books will vary with the group. So many factors enter into it that no one can set a certain length of time for the book to be used. The environment, the previous experience of the children, their racial and educational backgrounds, their mental ability, in some cases their language handicaps, all make for variation. The teacher will have to adapt the material to her group needs.

She should constantly keep in mind the major objectives of science teaching. She should remember that she is teaching not books, but children; that books are to help her attain the ultimate goal of education, the greatest possible development of the children she is teaching.

Good science books for children answer questions that children ask and stimulate further questioning. They answer those questions as simply, clearly, and in as interesting a way as possible. They are attractively made both as to text and pictures. They are within the reading ability of the group for which they are intended. They are as accurate as the authors and artists can make them.

The teacher using the books of The How and Why Science Series should feel free to use them to her best advantage. Since they are arranged seasonally, she may follow them through in sequence if she wishes. But if, for example, some problem concerning weather should arise before the first problem has been taught the teacher may use the material on weather to help answer the questions.

One of the authors has used these books in this way. For ex-

ample, during one winter a group of children wanted some help in making a feeding shelf for winter birds. She took copies of SUNSHINE AND RAIN with her to their room. They discussed together the kinds of birds that were likely to come to their shelf. They decided that chickadees, nuthatches, juncoes, house finches, and downy woodpeckers might come. These were the birds they had seen in the yard.

The kind of food these birds eat was discussed and it was decided that since some of them eat insects and some eat seeds they would need a variety of foods. The children named some foods they thought might be eaten by the birds. These were listed on the board. Then the teacher said, "I know some books that have a story of boys and girls who made a feeding shelf. Perhaps it would help you. Would you like to see these books?" The children were eager to have the books and many of them found the picture on page 78 before the teacher had time to finish passing the books. They looked at the pictures and were reading the story without any further stimulus.

After reading and discussing the story a question arose about the two birds in the picture, that were eating the suet. The children were not agreed as to whether they were chickadees, nuthatches, or downy woodpeckers. The teacher suggested that there were pictures on pages 74, 75, 76, and 77 which would help straighten out their difficulties. So before they were satisfied the children read those pages also.

The following day the children went outdoors and saw chickadees in the bushes by the school building. Other activities during the solving of the problem were the construction of a feeding shelf in woodworking, the bringing of suet and making wire feeders, bringing seeds and dried bread to put on the shelf, other trips out of doors to see the birds in which they were interested.

This illustration is one of many that might be given in which science books may function in meeting the needs of children. The teacher's job is to recognize those needs and to be alert to ways of working these into worth-while experiences. Otherwise, science teaching may be a hit-or-miss business. The outlines given in this Manual and the books themselves will help the teacher not trained in science to capitalize upon her children's interests. The

books may be used both to stimulate interest and to answer questions.

The teacher will find little difficulty with the actual reading. If the interest of the pupils has been properly stimulated they go from pictures to story so naturally that the teacher will be surprised at the ease with which the children read the words.

PROBLEMS PRESENTED IN *SUNSHINE AND RAIN*

		Pages in *Sunshine and Rain*
PROBLEM I	What is the earth like?	4–11
II	How are days different?	12–19
III	What can we see in the sky?	20–23
IV	How do we recognize the seasons?	24–27
V	What kinds of things are on the earth?	28–32
VI	What happens to living things in autumn?	33–47, 50–57
VII	How can we make homes for animals at school?	48, 49
VIII	How do people get ready for winter?	58–61
IX	How should we take care of colds?	62–65
X	How should you get ready for school?	66, 67
XI	How do you cross streets safely?	68, 69
XII	How do we know when winter is coming?	70–77
XIII	How can we help winter birds get food?	78
XIV	What can we learn from tracks in the snow?	79–81
XV	What happens to the days and nights in winter?	82–85
XVI	What happens to water in winter?	86, 87
XVII	What happens to animals in winter?	88–90
XVIII	How do bulbs grow?	91–94

ACTIVITIES USEFUL IN DEVELOPING THE CONCEPTS PRESENTED IN

SUNSHINE AND RAIN

BOB LOOKS UP AND DOWN

Pages: 4–5

Concepts:

We can go up in the air in an airplane.
Air is real. It goes up a long ways.
The sky is air. It goes on and on.

Suggested Activities:

This first story is to help introduce the concepts of the size and parts of the earth. A first-grade child knows only the environment with which he has had experience. He probably has heard the word *earth*—he may even know that a globe represents the earth—but the earth has no meaning to him until he identifies himself with it. This has been started in WE SEE but children soon forget and may repeat the same or similar activities before reading this story in SUNSHINE AND RAIN.

Begin by asking the children what they can see from their seats, then to name the most distant object that each can see from the window. They may say the sky, clouds, a tree, or a tall building.

Discuss distances, such as how far it is from one child to another; from one child to the door; from the door of their room to the door leading to the playground. Since first-grade children can't yet measure in feet, let them measure by counting the steps it takes to go from one place to another.

They may then go outside and estimate greater distances, such as how many blocks it is to the nearest store and so on. Lead them to some conception of distance in the air through discussion and observation. As they look at the pictures on pages 4 and 5, let them imagine that they are up in the air with Bob and tell how they think that the ground would look. If some child has been up in

an airplane, let him describe how objects on the ground appeared as the plane took off and went higher and higher.

It takes a long time for the concept of space to grow, so don't try to do too much in one lesson. The concepts of time and space are the most difficult of all science concepts to comprehend, but six-year-olds can begin to build toward an understanding of them. They can understand that they could see more of the earth if they could go higher, and that the earth goes on beyond what they can see. The concept that the earth goes out in all directions from the spot on which they live should be developed before trying to teach that the earth is a sphere.

Pages: 6–7

Concepts:

The earth is very large.
There is water on the earth.
The water is part of the earth.

Suggested Questions:

How high is Bob?
Is he as high as he was in the first picture?
What can he see? How far can he see?

Suggested Activities:

Most children have been to a near-by city and know that the distance is greater than to some place in their own community. Carrying on with the development of the size of the earth leads to the realization that the earth is very, very large—that instead of the short time it might take to go to the next town, it would take about two weeks by fast plane to go around the earth.

The next concept—that the earth is made of land, water, and air—should be demonstrated if possible with actual experiences. Go for a walk and observe that the earth is not just the soil, as some may think, but is made up of ponds, streams or lakes, clouds, and air. Discuss the fact that the water may look blue but that when a little of it is put in a glass it is not blue. The sky looks blue but it is just air like the air around us. The fact that the air is part of the earth may not be understood even by adults.

Pages: 8–9

Concepts:

The earth is very large.
There is water on the earth.
The water is part of the earth.
The land is part of the earth.
We live on the land.

Suggested Questions:

How does the earth look as Bob comes nearer to it?
Can he see as far?
Do the things he sees look the same as they did when he was higher up?

Suggested Activities:

Look at the pictures on these pages and compare with the pages preceding. Bring out the fact that when Bob was high in the air the buildings and fields looked like colored blocks, but that when he came down they looked larger and took on shape. If the children can go to the top floor of a building and look out of the window at some object on the ground, then go down and look at the same object near to it, it will help in understanding this concept.

Pages: 10–11

Concepts:

We can travel on the land.
We can travel on the water.
We can travel in the air.

Suggested Questions:

How do you go from one place to another?
How do other animals go from one place to another?
What do people have to help them travel over the earth?

Suggested Activities:

Let the children discuss all of the vehicles they can think of that travel on land, water, and in the air. Look for pictures of these vehicles and discuss what they need to run, sail, float, or fly. Let the children who have travelled in different ways on land, water,

or in the air tell how they did it. Keep stressing the fact that all of these are modes of travel on the earth.

DIFFERENT KINDS OF DAYS

Pages: 12–13 (Rainy Day)

Concepts:

Some days it rains.
Rain comes from clouds.
Rain is water.

Suggested Questions:

How does Mother know it is going to rain?
What are the differences between pages 12 and 13?
How does the air feel before a rain?

Suggested Activities:

Pages 12 and 13 enlarge the concept of *rain* introduced on page 8 of We See. It should be related to the children's experiences by a discussion of times that they have been in the rain.

Discuss the way the sky looks before it rains. If possible, feel the moisture in the air before a rain. In humid regions, moisture is apparent in the air because it collects on the tops of salt shakers, on cold objects, and even on walls and clothing. In dry regions, this is not so noticeable but children may have heard their mothers say that it was hard to dry clothes because the air was so damp. The main idea to bring out here is that there is water in the air, high up as clouds, that comes down as rain—the beginning of the water cycle.

The best time to introduce this story would be on a rainy day. Then when the children come in with wet raincoats and umbrellas they will enjoy discussing Bob and Susan. Bring out the fact that Bob and Susan seem to like the rain because they are dressed for it.

Page: 14 (Foggy Day)

Concepts:

Some days we have fog.
Fog is water.

Suggested Questions:

How does the air look in the picture?
Have you been in a fog? How did it feel?
How do objects look through a fog?

Suggested Activities:

Fog isn't so commonly known to many children as rain, so they may need help in understanding it. Recall the discussion of fog in connection with page 4 of We See.

The teacher may ask, "Do you know how the air in the laundry looks when the air is full of moisture from the hot water?" or "Have you been in a bathroom or shower when the hot water was turned on and the air was full of water? Did it look like the air around Bob?"

The children should discuss any fogs they have seen, such as the small patches of fog that condense over fields, in low places, or above bodies of water. Sometimes they may have been in a car that was under a viaduct when clouds came down from steam engines. Such clouds are similar to fog.

Again, we should stress that the teacher must be careful not to give the inaccurate concept that we see *steam*, for steam is invisible. Fog is tiny drops of water that have condensed around bits of dust or smoke in the air. Fog is a cloud that has formed on the earth's surface.

Page: 15 (Sunny Day)

Concepts:

Some days are sunny.
The sun warms the earth.

Suggested Questions:

How do you feel on a sunny day?
Look at the picture on page 13 and tell how it is different from this picture.

Suggested Activities:

Go out into the sunshine or feel it through an open window. Compare the way everything looks on a sunny day with the way it

looks on a rainy or foggy day. Bring out the difference in the way we dress, the way colors look, and the way we feel on a sunny day.

Discuss the fact that the sun is shining on the rainy day but that the tiny water drops are like a screen that hide it from us.

Demonstrate the way the earth heats the air by feeling rock, sidewalks, soil, or objects that are in the sun. Feel the air right above them, then farther away. The sun's rays are not heat rays but cause the objects on the earth to become heated. If they were heat rays, it would be warmer as we go higher in the air toward the sun. Since there are few solid particles in the air, air is heated but slightly by the rays of the sun as they pass through.

Pages: 16–17 (Snowy Day)

Concepts:

Some days we have snow. It comes from clouds.
Snowy days are cold.
Snow is water.
Warmth from the sun melts the snow.
Snowflakes are beautiful.

Suggested Questions:

Does this picture show the same time of year as the one on page 15?
How can you tell that it is winter?
Do you think it has started to snow or that the snow is almost over. How can you tell?
How are all of the snowflakes on page 17 alike? How are they different?

Suggested Activities:

It would be ideal if this lesson were to come at the time of or soon after the first snowfall. Children who live where it snows should look at snowflakes through a hand lens. The flakes may be caught on a dark piece of woolen cloth at an open window, or examined out of doors on coats. Note that while all perfect snowflakes have *six* points, no two are identical in pattern.

Snowflakes are formed when saturated air, high above the earth's surface, is chilled to below freezing. Instead of condensing

to form drops, the vapor goes directly from the gas to a solid form. It condenses around particles of dust in tiny needle-like prisms. These ice prisms have six equal sides, and they build six spokes around the bit of dust. The spokes are filled in with other crystals. The size of the flakes depends upon the temperature of the air. If it is just below freezing, there is more time for the crystals to grow larger and to make big, feathery flakes. When it is very cold, they are precipitated out of the air so fast that they make tiny crystals and flakes.

The children should melt snow to discover that it not only makes water, but that there is much less water than snow. A large pan full of snow makes very little water. This is because snow has so much air between the flakes. As snowflakes fall to the ground, much air is imprisoned between the flakes. Snowflakes differ in their water content—the fluffier the snow, the less water.

Pages: 18–19 (Windy Day)

Concepts:

Some days the wind blows.
We cannot see the wind. We see what it does.
We can feel the wind.
The wind can be harmful but it can also be useful.

Suggested Questions:

What is happening to Susan?
Have you ever tried to make a leaf house?
Why can't Susan make one?
What can you feel but not see?

Suggested Activities:

Ideally, the concept of wind should be presented on a windy day. Though all children have felt the force of wind and have seen what it does, they may not have thought about it.

On a windy day they should notice and list all of the things that the wind is moving. Discuss hard winds and gentle winds, and notice the difference in the way dust, leaves, and other objects are blown.

The children may make long strips of paper and watch the wind

lift them as they hold one end. They will feel the force of the wind in the pull on their fingers.

Let them name all of the things they can think of that are moved by the wind. If the school is near a pond and it is possible to do so, let the children make simple sailboats and sail them. A flat cork with a paper sail held up with a stiff piece of wire stuck into the cork will demonstrate the point.

A simple windmill may be made of paper and fastened to the window sill. The children should notice that it goes around with a slight breeze, going faster as the breeze becomes a wind.

Review the kinds of days by keeping a record of the days for a week or two. The teacher may write this record on the blackboard as the children dictate. This will be a beginning of weather study and give the children the correct attitude toward recording data.

IT IS DAY

Pages: 20–21

Concepts:

The sun is in the sky. We see it in the daytime.
We get light from the sun.
We get heat from the sun.
Light helps us see.
Sunlight helps living things grow.

Suggested Questions:

We have been discussing different kinds of days. What makes the day?
How do we know when the sun is shining?
Can we always see it in the daytime?

Suggested Activities:

These pages are made up of the concepts started on page 10 of WE SEE and put into words that the children can read. Take the children to a sunny spot and let them feel the sun's heat. Notice the difference in the way the parts of their bodies feel where the sun's rays strike them and where they don't. Feel the ground and

other objects in the sunshine and in the shade. Notice the difference in the way objects look in the sunshine, shade, and a place where little light enters.

Notice the position of the sun at different times during the day. Mark places where sunlight falls on the floor or blackboard at different times. Discuss the picture on pages 20 and 21, and let the pupils tell where they think the sun would be if they could see it. The sun isn't represented in the picture, because an accurate painting of the sun cannot be made, and children should not look *at* the sun. After the basic understanding of the sun has been developed, pictures representing the sun are not so likely to teach misconceptions. Be careful not to speak of the sun as *moving*, but simply that it is in different positions because our spot on the earth is moving toward the sun in the morning, past it at noon, and away from it in the afternoon. Later, in THROUGH THE YEAR, these concepts are developed further.

NIGHT COMES

Pages: 22–23

Concepts:

At night we cannot see the sun.
The moon shines at night.
Moonlight is not so bright as sunlight.
Stars shine at night.
Starlight is not so bright as moonlight.
Moonlight and starlight keep the night from being absolutely dark.

Suggested Questions:

What happens to the sun at night?
What can you see in the sky at night?
Can you always see the moon at night?
What is the difference between sunlight and moonlight?

Suggested Activities:

The purpose of these pages is to lay the foundation for an understanding of the earth's movements and the reasons for the moon's

light and apparent changes in shape. Again, the text puts into words concepts expressed in the pictures on page 11 of WE SEE.

After learning that we have day because our spot on the earth is toward the sun, the children should learn that we have night because our spot has turned away from the sun. The teacher shouldn't attempt to *make* children repeat these facts. This is too large a concept for them to learn all at once, but starting with these simple experiences the children may build large concepts by adding other experiences as they are ready for them.

FROM AUTUMN TO AUTUMN

Pages: 24–27

Concepts:

There are four seasons.
Autumn is a season.
Apples ripen in autumn. Leaves fall.
Winter is a season.
The apple tree is bare in winter.
Weeds are brown in winter.
Snow falls in winter.
Spring is a season.
Buds open on the apple tree in spring. Leaves and flowers come from the buds.
Summer is a season.
The flowers grow into apples during the summer.
The leaves grow larger.

Suggested Questions:

What time of the year is it now?
How can you tell that it is winter? (or autumn?)
What time of the year was it before winter?
Why is the apple tree bare in winter?
Why do the buds open in spring?

Suggested Activities:

In WE SEE, activities of children were used to develop the ideas of the seasons. Children are usually aware of the season. That is,

they can tell you that it is summer or winter. But they do not think of seasons in sequence. Nor do they often know the word *season.* It hasn't been used in the text but the teacher should develop the word orally as she discusses each season with the children.

In discussing sunny days and snowy days, the children probably have used the words *winter* and *summer.* They may have brought out the idea that the days are longer in summer than in winter, therefore there is more sunshine. Now they are ready to differentiate further.

The word *autumn* is used and not *fall* because autumn is the correct word. If children start using correct words, they won't have to change later. When it is possible, correct words should always be taught children rather than substitutes having vague or inaccurate meanings. Where it is not possible to use these words in the text, because of vocabulary difficulty, we shall try to give them in this Manual so that the teacher may use them.

An apple tree is used here as an example of seasonal change because it is common in many parts of the United States and also because its cycle is so pronounced. In a region where apples do not grow, any other tree may be observed. The children should go for a walk early in the school year and choose some tree to watch all year. They may then compare its changes with those of the tree in the story.

The four pages may be used separately or together. On an autumn walk, children might look at different trees, depending upon the varieties available. They might pick up apples, nuts, or other fruits that have fallen from the trees. Their attention should be called to the temperature by a question like, "Is today different from a summer day? How?" Since the first question can be answered by "Yes," the "How?" is necessary to stimulate thinking comparatively. Soon the teacher can eliminate the first step and ask "How is an autumn day different from a winter day?" or "How do you know when autumn is over and winter is here?"

After observing and discussing the changes that have gone on for several weeks, the children will be ready to look at and discuss the pictures on these pages. If the four pictures are discussed before any of the text is read, the seasonal cycle will be more evi-

dent. The word *season* may be used either before or after reading. When the teacher sees that the children have gained the concepts of autumn, winter, spring, and summer and realize that there is a cycle of plant, animal, and weather changes, she may say, "We have one word for these four times of the year. Would you like to know what it is?" If some child doesn't guess it, the teacher may say "We call autumn, winter, spring, and summer *seasons*. The seasons follow one another. There isn't any great change when summer goes into autumn and autumn into winter. But there is a great difference between the middle of summer and the middle of autumn. From the middle of summer to the middle of winter, it gets colder and colder. Then from the middle of winter to the middle of summer it gets warmer and warmer. Let's watch the days to see if that is true. We may have some days that are warmer than others but it is gradually getting colder."

All through the year the children should keep coming back to these pages to check them with their observations. They may use page 3 in the Companion Book to record what they have learned. As a review, the teacher may have a number of mounted, colored pictures around the room. Let each child select a picture and tell what season he thinks it shows and why.

PLANTS

Pages: 28–29

Concepts:

Plants live on the earth.
Plants need water and sunshine to grow.
Some plants live in water.
Some plants live on land.
Plants are different sizes.

Suggested Questions:

What living things can you see in this room?
Which of them are plants? How do you know?
How are the plants alike?
How are they different?

Suggested Activities:

The purpose of these pages is to develop further the concepts started on pages 16 and 17 of WE SEE—that plants are alive, that they feed and grow. Through discussion and comparison of plants in the room, a greenhouse, or garden, children should gain the idea that there is a variety of plants growing in different kinds of places. The more plants they can see and discuss before reading the text, the more interesting and meaningful the reading will be.

ANIMALS

Pages: 30–31

Concepts:

Animals also live on the earth.
Animals live in the water and on the land.
There are many kinds of animals.

Suggested Questions:

Can you see any animals in the room?
How are they all alike?
How are they different?
What animals do you see in the pictures on pages 30 and 31?

Suggested Activities:

These pages are intended to help develop the concepts that all living things that are not plants are animals; that animals may live in water or on land; that there is great variety in the structure of animals.

Since many people have the misconception that animals are covered with fur, it may take many experiences to teach children the correct concept.

Before discussing the pictures on the pages or reading the text, the children should observe and discuss as many animals as possible. Some of those easily brought into the schoolroom are insects, spiders, caterpillars, earthworms, snails, turtles, frogs, salamanders, fish, rabbits, ducks, chickens, small harmless snakes, and kittens. Bring out the main characteristics of living things—that they breathe, eat, and grow. Then compare the animals with

plants, the only other living things. Although scientifically the differences between the simplest plants and animals are very slight and too technical to be understood by a child, between higher forms there is no confusion. The children will probably say that animals move from place to place and plants can't. Animals feed in a different way from plants, and breathe differently.

To learn that human beings are animals may be a shock to some children and they may argue about it. When a child says, "My mother says so and so," the wise teacher doesn't try to change his mind. The child's faith in his parents is more important than a misconception at this age. Through observation and science experiences, he will learn as he grows older to evaluate convictions held by older people. The scientific attitude of respect for the opinion of others in no way interferes with belief in the truth. As a child develops scientific attitudes, he learns to think for himself and to react intelligently rather than emotionally to new ideas. But at six he is still dependent upon his home for his security. Mother and Father are usually right in most homes, and a teacher needs to be careful not to shake this confidence.

The animals with two legs are the boy and the pheasants.

The ones with four legs are the cow, cat, and dog. Fish have four appendages—fins—which are analogous to legs.

The snake has no legs.

Page 4 in the Companion Book is designed to bring out the differences in land and water life. Some of the animals and plants that the children might draw in the aquarium are:

Plants:	Animals:
eelgrass	snails
water milfoil	tadpoles
duckweed	fish

In the terrarium they may put:

Plants:	Animals:
moss	toad
grass	salamander
ferns	snake
	caterpillars

Page: 32

Concepts:

There are things on the earth that are not alive.
Rocks are not alive.
Airplanes are not alive.
Snowflakes are not alive.
Kites are not alive.
The sun is not alive.

Suggested Questions:

We have talked about the things in the room that are alive. What are some things that are not alive?
How do you know they are not alive?
Have any of the things you named ever been alive?
Airplanes and kites fly. So do birds. Birds are alive. How can airplanes fly if they aren't alive?

Suggested Activities:

As in the preceding activities, observation and discussion should come before reading the text. In naming the things in the room that are not alive, the children may list such things as tables, chairs, chalk, erasers, stove or radiators, books, rulers, pencils, hooks, vases, and so on. When asked which ones were once alive, they should name things made of wood since these were once live trees. Things not alive do not breathe, feed, or grow.

In the picture on page 32, the sun, airplane, rocks, soil, kite, and snowflakes are not alive.

A WALK AT SCHOOL

Pages: 33–47

Concepts:

Apples ripen in autumn.
Leaves of many trees change color in autumn.
Trees stop growing in autumn.
The leaves fall from some trees.

Squirrels find nuts to store in autumn.
Chipmunks are hiding seeds in autumn.
In early autumn we still see insects.
We can tell insects by their six legs.
Some caterpillars make chrysalids.
Toads and garter snakes are sluggish in autumn. They will soon hibernate.
Garter snakes are harmless.

Suggested Questions:

What is happening to the trees in autumn?
Do the leaves on all trees change color and fall?
Do all of the animals that we see in the summer stay around all winter? What do you think happens to them?

Suggested Activities:

Ideally, this story should be read following an autumn walk where the children have observed some of the things mentioned in the story. Obviously, first graders cannot read when school begins, but they can look at the pictures and discuss them following such a walk. This will help them to recall the experience when they are able to read later.

Field trips are a very important part of any science program, but they should be carefully planned activities, not aimless walks. Children usually associate the out of doors with play and have to be taught that in science we may use a walk as a means of getting information.

In the first grade, the purpose of field trips is mainly one of acquainting the children with their environment and helping them to develop an appreciation for it. Before going on this first trip, the teacher and children should discuss the fact that there are many ways to learn about living things. One way is to watch living things in the schoolroom. Since living things do not always behave in the same manner indoors as they do in their natural homes, a better way to learn about them is to go out of doors, and observe them in their natural homes.

Ask the children what they think wild creatures will do if they see and hear a group of children. To approach animals and watch

them, we must walk quietly and slowly, stopping if the animals are startled. Most animals are startled by quick movements, such as pointing, but can be approached by a person who is patient. A whole class of children may be led to within a few feet of birds or other animals, if they move cautiously. Children are eager to cooperate when they understand how to do it and even a restless six-year-old gets such a thrill out of such an experience that he is anxious to do his best.

The simplest accurate explanation of changing color in leaves is that the trees have stopped working and growing. The leaves are the food-making factories of the tree. They use water from the soil and a gas (CO_2) from the air to make food. Much food is stored through the summer in the trunk, branches, and roots. At the end of the summer a thin layer of tissue grows across the leaf stem (petiole) between it and the leaf. The leaf can no longer work without water. The green coloring matter (chlorophyll) dies, disintegrates, and unmasks the yellow pigment (carotin) which is always present in green leaves. The red is due to other chemical substances in the leaf. But it is *not* frost which causes the change in color. A sudden frost while leaves are still green and working will make the leaves turn brown and wither. Since this process is too complicated to explain in first-grade vocabulary, and probably wouldn't be understood, we can simply say, "Trees stop growing." The teacher must use her judgment if the question arises as to how much she should tell the children. They should observe different trees and shrubs, noticing what happens to the leaves. The colored leaves are so pretty that children like to gather them. As they do this, they may compare the leaves from different trees to note the fact that though all have a similar shape, no two are exactly alike. We are continually trying to develop concepts that have an application to scientific principles, one of which is the law of variation.

Squirrels and chipmunks are two mammals that live in many parts of the United States. They belong to the same class and are similar in many ways.

Squirrels collect nuts and hide them in various places—the ground, holes in trees, and even in attics. This collecting is instinctive. Squirrels would collect nuts in the spring or summer

were nuts available. The collecting is *not* preparation for winter in the sense that human beings anticipate cold weather and prepare for it. Red squirrels, fox squirrels, gray squirrels, Abert squirrels, and many other varieties are found in the United States. The teacher will have to adapt the material to the type found in her region. If there are no squirrels, some other mammals may be observed instead.

Chipmunks gather all kinds of seeds, including small nuts and acorns. They are interesting to watch as they stuff their cheek pouches almost to bursting. They are easily tamed with peanuts, which they will tuck away at any time of the year, when their appetites are satisfied. They live in underground burrows having storage rooms and sleeping rooms. In winter they go into their burrows to remain until the first warm, spring days. They sleep part of the time, waking up to eat.

We think that detailed study of such insects as bees and grasshoppers is too advanced for first grade. The children should observe them, however, and know that they are insects. The fact that all insects have six legs is a simple way to distinguish them, and one which six-year-olds enjoy. Avoid using the word *bug*, since only one order of insects—the one to which stinkbugs, bed bugs, and cabbage bugs belong—can be so named.

If the children want to catch grasshoppers, they may keep them for a while in glass jars containing soil in which oats, wheat, or corn is sprouting. The jars should be prepared far enough in advance for the seeds to be well sprouted. One grasshopper to a jar is enough. Females may lay eggs in the soil.

If any cocoons or chrysalids are found, collect them carefully, cutting the stems or twigs to which they are attached. The chrysalis in the picture is that of the Monarch or milkweed butterfly.

The snake pictured is a garter snake. Few small children are afraid of snakes. When they are, it is because they have been frightened by an older person. Since most snakes are helpful and few harmful, we should teach children to respect but not have an unreasoning fear of snakes. The best way to do this is for the teacher herself to overcome any fear she may have. If a harmless snake is seen on a trip, stop and watch it. If it is startled, it will try to escape. If not, it may go on feeding or sunning itself. When

everyone has observed it, go quietly away. Discuss its food and why it shouldn't be killed.

A small garter, green, or milk snake may be captured in a jar and put into a terrarium for a few days observation. It may be fed live earthworms. Be sure to have a well-anchored lid on the terrarium or your snake may disappear some night and turn up sometime later in another room—where it may not be welcome!

Pages 46–47 are to teach that any animals collected must be cared for; also that there should be a reason for collecting them.

HOMES FOR THE ANIMALS

Pages: 48–49

Concepts:

Water animals need a container with water, sand, and plants growing in it. It should be as much like a pond as possible.

Land animals need a container with soil in it.

Some plants should be growing in the soil.

We should always care for any animals we bring in from the out of doors.

Suggested Questions:

In what kind of place did these animals live?

How can we make them comfortable in our schoolroom?

Suggested Activities:

The children should be taught how to care for any animals which they bring to school and to release them when they are through studying them. Toads, frogs, salamanders, lizards, snakes, and turtles may be kept through the winter without harm to them if placed in the right kind of terrarium, given enough moisture, and kept in a cool place.

All of these animals may be fed on earthworms or live insects. Turtles will usually eat bits of meat or prepared turtle food. Since live food is not easy to obtain in winter, it is best to release animals that need it and which ordinarily will hibernate through winter. If the teacher wishes to keep them, however, she will find directions for raising live food under the section on terraria.

Although we do not want children to have an unreasoning fear of snakes, we do not want them to be so over-bold as to chase or try to catch them. We teach that not all snakes are harmless, therefore they should be left alone. A large garter snake may bite if caught and handled roughly, and though its bite is not poisonous, nor even very painful, it might cause trouble and frighten a child. In the hands of a person who doesn't fear it, a snake may be held firmly but gently without danger of exciting it. But unless a teacher can do this, she should keep the snake in a jar as the children discuss it. Small snakes, except for poisonous varieties, are harmless.

Snakes do not sting with their tongues as popularly supposed. They feel vibrations with their tongues and may use them for hearing. All snakes have small curved teeth with which they pull food into their mouths. Much can be learned of the habits of snakes by keeping one in a terrarium for a while and watching it eat. It may even shed its skin while there.

In making homes for animals, discuss their natural habitats and let the children suggest ways of making the substitute homes as much like the real ones as possible.

TWO CATERPILLARS

Pages: 50–54

Concepts:

We find caterpillars in autumn.
Caterpillars eat leaves.
Some caterpillars make cocoons in autumn.
Some caterpillars do not make cocoons in autumn.
Some caterpillars are fuzzy and some are smooth.

Suggested Questions:

What are caterpillars doing in autumn?
How can we find out what is going to happen to them?

Suggested Activities:

Many different kinds of caterpillars are spinning cocoons or making chrysalids in the fall. Some are going into the ground to

pupate. The children should be told to bring in some of the plants on which they find the caterpillars. That will help the teacher to know what kind each caterpillar is and what to feed it. If she cannot identify the caterpillar, it is just as valuable to keep it until its transformation into a butterfly or a moth and then find out what it is.

Some of the common caterpillars, like the cabbage "worm," tomato "worm," and carrot "worm" make just as interesting life-history studies as the more uncommon ones. Information about these types may be found in the reference books on moths and butterflies.

The two caterpillars mentioned in the story are used because they are common in most parts of the United States. The green caterpillar is the larva of *Telea polyphemus*, the Polyphemus moth. It is found on a variety of shade trees including elm, maple, and fruit trees.

The Woolly Bear described and pictured is the larva of the Isabella tiger moth. It feeds on a number of common weeds. In September large numbers are seen crossing sidewalks and highways. They are on their way to find hiding places for the winter. Early in spring these Woolly Bears come out of hibernation, eat ravenously, then spin cocoons and pupate. They use their own hair in making their cocoons. About ten days after spinning, the yellow and orange moths emerge.

There are other common Woolly Bear caterpillars that do not hibernate in the larva stage but the Isabella is a children's favorite.

Directions for caring for caterpillars are given in the first part of this Manual.

Directions for making a terrarium are also given in the first portion of this Manual. Terrariums have so many uses that every school should have several.

THE SURPRISE

Pages: 55–57

Concepts:

A butterfly comes out of a chrysalis.
Some butterflies fly away for winter.

Suggested Questions:

What is the difference between a chrysalis and a cocoon?
How does a butterfly get out of a chrysalis?
What do you suppose happened inside the chrysalis between the time the caterpillar made it and the time the butterfly came out?

Suggested Activities:

One purpose of this story is to develop appreciation of the beauty of a butterfly. There is nothing more interesting or exciting to a child than watching a butterfly emerge. It is a rare experience that few people have. Consequently, if possible, a first-grade room should have as many chrysalids as possible to make the chances of having the experience more certain.

When a butterfly emerges from the chrysalis, its wings are folded twice, and crumpled. The insect needs something to which to cling while unfolding and drying its wings. Twigs or the screening of a wire cage are good supports. The wings must have room to hang while fluid and air are being pumped into them, or they will dry deformed in shape. This process takes several hours. When the butterfly begins to move the wings back and forth, you will know it is getting ready to fly. As one small boy exclaimed, "Boy, he is warming up his motor!"

Many butterflies may be fed sweetened water, if enticed with a drop on the point of a pin. Gently touch the butterfly's proboscis and watch it unroll its long, sucking tongue to drink. The butterfly will cling to your finger while drinking.

The Monarch and quite a few other kinds of butterflies migrate in autumn. The Monarch finds protected spots in a warm climate and clings in huge masses to trees and bushes. There the insects remain dormant until spring, when they start north. When they find milkweed plants old enough to feed the young caterpillars, they lay their eggs and die. The Monarch butterfly which migrates in autumn probably does not get back to its original home the following spring, but its progeny may.

After the children have enjoyed seeing their butterflies emerge and eat, they should release them out of doors.

The Companion Book: *Pages* 7, 8, and 9.

These pages should help with the concepts involved in the stories of moths and butterflies. These insects belong to the same order and have the same stages in their life histories. Unless one is familiar with the species, there is no way to tell the eggs and caterpillars apart. In the pupa stage, however, one knows that no butterfly larva spins a cocoon. Their chrysalids are naked pupae with only a few threads of silk to anchor them to a support.

The native silkworm moths, such as Cecropia, Polyphemus, and Luna moths, all spin cocoons. So do the Tiger moths and many others. Most of the Sphinx moths, such as the one commonly called tomato worm, do not spin cocoons but go into the ground to pupate. Their smooth, brown, jug-shaped pupae are often found when one is digging in the garden.

The purpose of teaching children to differentiate between moths and butterflies is to lay a foundation for later understanding of the importance to human welfare of some of these insects.

READY FOR WINTER

Pages: 58–61

Concepts:

People have houses to keep them warm.
People have warm clothes.
People know that winter is coming and can, freeze, or dry food to store for winter.
Food helps keep us warm.

Suggested Questions:

Why do your mothers can food?
How do people get ready for winter?
Why do they get out the blankets and air them?
Why do you need more food in winter?

Suggested Activities:

This is a health lesson to bring out the fact that we need warmer clothing and more food in winter than in summer. Let the children discuss what is done in their own homes. If it isn't too late in the

season, they may make jelly or jam at school, gather walnuts, apples, or other available foods. They may help gather old clothes for any needy families who might be cold without them.

Be sure to bring out the differences between the behavior of human beings and the lower animals. People know that winter is coming and prepare for it. Other animals hibernate, migrate, or store food by instinct. Storing food is a physiological process—a part of their life cycles—just as nest building or feeding is.

SUSAN'S COLD

Pages: 62–65

Health Concepts:

You should not go to school but should stay at home when you have a cold.

You should not play with other children.

You should cover your mouth with a handkerchief when you sneeze.

It is best to stay in bed when you have a cold.

Suggested Questions:

How do you know when you have a cold?

Why should you stay away from other people when you have a cold?

Why should you cover your mouth when you cough or sneeze?

Why should you use cleansing tissue or a clean handkerchief?

Suggested Activities:

The teacher can do as much with this lesson as she desires. Paper handkerchiefs should always be available in a primary room, and time taken to discuss their use and disposal. Also important is the training in washing hands often when one has a cold. Children should go home if possible when they have colds, but if they have no one at home to care for them, the teacher should move them away from the other children. This should be done tactfully so that the sick child doesn't feel that he has done something wrong.

If the teacher herself *has* to teach when she has a cold, she can use the misfortune to teach the importance of staying away from

other people. Explaining the reason, she can keep as far from the children as possible. She should cover her mouth when sneezing or coughing, and wash her hands after using her handkerchief. Of course she should be at home also, but sometimes this seems impossible. If one could think of colds as one does of scarlet fever, there would be fewer of them.

READY FOR SCHOOL

Pages: 66–67

Health Concepts:

Each morning you should
wash your hands and face,
brush your teeth,
brush and comb your hair,
dress neatly in clean clothes,
eat a good breakfast of fruit, cereal, milk, egg, and toast.

Suggested Questions:

How did you get ready for school this morning?
What is Jimmy doing?
Why should you do these things?
What is Jimmy having for his breakfast?

Suggested Activities:

The purpose of this story is to present health experiences in such a way that the children will see their value. The reason much health teaching has not been functional is that it has consisted largely in learning health rules. To practice these rules, children must be interested and want to follow them.

Actually, some of the concepts presented are social rather than health concepts. We have no evidence to prove that the child who bathes, wears clean clothes, and brushes his hair has any better health than his dirty neighbor. But wholesome food is another matter.

An activity children enjoy is to choose meals from pictured ones in a play grocery store. This helps them to choose better-balanced meals in the lunchroom and also encourages them to eat better

meals at home. However, there is always the child who through no fault of his own, doesn't get the proper food at home. He must not be embarrassed.

In the story, all of the details of keeping clean are made attractive. Eating a good breakfast is also pictured as an enjoyable experience. Discuss the reason for Jimmy's pleased expression.

GOING TO SCHOOL

Pages: 68–69

Safety Concepts:

Be careful when crossing streets.
Stop at the curb.
If there are lights, cross with the green light.
If there are no lights, look to your left.
If there are no cars coming, walk to the center of the street. Stop. Look to your right. If no cars are coming, walk to the curb.

Suggested Questions:

What are some of the things you need to look for before crossing a street?
Should you run across the street?
Should you ever run out from between parked cars?
Where should you always cross a city street or highway?
How is Jimmy being careful?

Suggested Activities:

The authors of these books believe that the most important concepts to teach children are those that keep him well and safe. All of the science facts in existence won't help him if he is killed or maimed by an accident. One of the first things a six-year-old needs to learn is how to go to school safely, crossing streets both with and without lights. Many primary rooms have green and red lights which they use for practice in developing this concept.

Many first-graders also need practice in telling which is right and which left. Teachers should adapt this lesson to their particular situations.

WINTER WILL SOON BE HERE

Pages: 70–77

Concepts:

Changes take place as winter approaches.
Some trees have lost their leaves.
Evergreen trees do not lose their leaves.
In late autumn the insects are gone. Some have died; some are hiding in protected places; some have flown away.
Woodchucks are going into their holes for the winter. They will use their stored fat through the winter.
Many birds have flown away.
Chickadees, nuthatches, and downy woodpeckers are winter birds.
Nuthatches go down a tree eating upside down.
Birds eat insects and seeds.

Suggested Questions:

What has happened to the plants and animals since the trip we took the first week of school?
How are the trees different?
Have all trees lost their leaves?
What is the difference in the shape of the trees that have lost their leaves and those which haven't?
What has happened to the garden plants?
Can you find any insects?
What will the winter birds find to eat?
How can we help them?

Suggested Activities:

This story is for the purpose of comparing late autumn with early autumn. It should be preceded by a walk to observe and discuss the changes in the particular environment in which the children live. Even in the southern states there are seasonal changes which may be compared with those brought out in the story. An interesting activity for children in the southern states is to note the birds that are arriving from the north. Discuss the fact that many of the birds that they are seeing in winter spend the summer where the children of the story live.

Migration is not fully understood, though ornithologists have some theories about it. It is important for children to know that scientists haven't found all of the answers to their problems. That birds do move from season to season is a fact, and children can notice and discuss which ones go and which ones remain.

On page 77 are pictures of three birds not mentioned in the text because of vocabulary difficulty. They are the goldfinch, male and female; horned lark; and pheasant. Goldfinches molt in autumn and their new feathers are a dull gray in contrast to their bright yellow summer plumage.

While identification isn't an objective for teaching science, much of it comes as a result of interest. A good bird book for the region, with colored pictures, should be available in every school. The teacher and children should look for pictures of the birds they see on trips and try to find the correct names. What little children learn remains permanently in their minds. If the teacher uses correct names for plants and animals seen on trips, the children will use them.

THE LUNCH COUNTER

Page: 78

Concepts:

The ordinary food of birds may be covered in winter.
We can feed the birds.
Sparrows and goldfinches eat seeds and crumbs.
Chickadees and nuthatches eat insects, so we put suet out for them.
Birds will eat cracked nuts.

Suggested Questions:

What do the birds that are here now eat?
What foods that are like their ordinary food can we give them?
What would be most like weed seeds?
What would be most like insects?

Suggested Activities:

To feed birds, an elaborate feeding device is not necessary.

Seeds, crumbs, the sweepings from a mill, cracked nuts, and meat scraps may be sprinkled on the ground under a tree or on a window sill. But a simple shelf, preferably with a roof to keep snow off, provides a better place where children may watch the birds. While we do not encourage English sparrows to come to the feeding places, they are interesting to first-graders, and their coming attracts other birds.

A comparison of sparrows—typical seed-eating birds—with chickadees, nuthatches, and woodpeckers—insect-eating birds—will bring out the differences in the shapes of their beaks. Seed-eaters have strong, short, thick beaks used for cracking seeds, while insect-eaters have slender, pointed beaks, used for getting insects out of crevices in bark or buds.

Crushed nuts of all kinds are relished by all kinds of birds because they need the fat in winter. The nuts may be crushed in a canvas or burlap bag, with a hammer. If they are merely cracked, squirrels and large birds, such as the jays, may carry them away and the children will not have the opportunity of watching the smaller birds eat.

See the section on winter bird feeding in the first part of this Manual for further suggestions.

TRACKS IN THE SNOW

Pages: 79–81

Concepts:

Animals make tracks when they walk in the snow.
Many animals hunt for food at night.
In the morning you can tell which animals were out the night before, if you know their tracks.

Suggested Questions:

What kind of tracks do you make when you walk in mud, snow, or wet sand?
How can you tell by a footprint which way a person is going?
Does a dog or cat make the same kind of tracks that you do?
How do a rabbit's tracks look?

Suggested Activities:

Tracking animals is fun, whether in snow, wet sand, or mud. On a mild morning after a light snowfall, it is easy to follow tracks and try to interpret what the animals were doing the night before. The children may try to tell the story written in tracks on a smooth white field or lawn.

The purpose of track study is to awaken an interest in the out of doors in winter and help develop the ability to interpret natural phenomena. It also emphasizes the fact that living things are active, even in winter.

Tracks of familiar animals should be learned first. Even dog and cat tracks may puzzle a beginner in trying to tell which way the animal was going and how it used its feet. Before going outdoors the children may see how tracks are made by letting a dog with wet feet walk across the floor. Repeat with a pet cat and compare the two. If someone has a pet rabbit or guinea pig, the activity may be repeated to show the difference in the way animals walk. Rabbit tracks seem to go in the reverse direction. The rabbit puts its forepaws down, then its hind feet go ahead of its front ones as it hops.

The children should discuss the reason they see rabbit tracks, but not woodchuck tracks; also, that they see some bird tracks, such as quail or pheasant, but not others.

On pages 80 and 81, there are rabbit, squirrel, sparrow, dog, and human tracks. The children should try to find in the picture the animals that made the tracks.

WINTER DAYS

Pages: 82–85

Concepts:

The days are short in winter.
The nights are long in winter.
The sun rises late and sets early.
When the sun doesn't shine so long, it is colder.

Suggested Questions:

Is it as light now when you get up as it is in summer?

What do we get from the sun?

What kind of weather do we have when the sun doesn't shine much?

Suggested Activities:

The purpose of this story is to lay a basis for an understanding of change of seasons. The principle underlying seasonal change is too difficult for six-year-olds to understand. However, observing the changing position of the sun as winter approaches, observing the change in the time it rises and sets, and noting that less sunshine makes less heat, all contribute to a later understanding of the principle.

An activity to help teach these concepts is to note each day at the same time, the position of the sun in relation to some tree or building. This may be recorded on a large picture or by means of individual pictures. Each day at the same time put the sun in the new position in the picture. This procedure should be followed for a week in winter and a week in spring, using the same time and tree to mark the position. This is a start toward teaching the children how to collect and record data, one of the steps in problem solving.

ICE

Pages: 86–87

Concepts:

Water freezes to make ice when it is very cold.

Ice is clear and slippery.

Icicles are ice. They are pretty.

Ice melts when it gets warm.

Snow is frozen water.

Suggested Questions:

Where have you seen ice?

What does it look like?

How does it feel?

Where do icicles form?

In what kind of weather do we have ice and snow?

Suggested Activities:

Things which seem very simple to adults are often quite thrilling to children. Just freezing water in a bottle and watching the results may be quite an experiment for children. In order to get the most out of the experiment, water should be put into containers of different sizes and shapes. Bottles and tin cans may be used. The tin cans will bulge, showing that water expands in all directions as it freezes.

While the physical properties of ice seem obvious to an adult, with children these have to be discovered.

Break a piece of ice from a clear piece and try various things with it. Look through it to see that it is clear. Break it to discover brittleness. Drop a piece in water to find that it floats. Let the sun shine through a piece to see the sparkle.

If there is a hoar frost during the winter, the children should notice the little crystals of ice that stand up on every twig and branch. Use a hand lens to look at the frost.

Examine icicles of different shapes and discuss possible reasons for their shape. Cut one across and notice how it formed in layers. Notice how a drop spreads around the core as it runs down, making layer after layer.

In regions where ice doesn't form, ice cubes may be examined to see the characteristics of ice. A glass of water may be packed in ice and salt and the formation of ice crystals observed.

Companion Book:

The exercise on page 24 provides a place for the children to record the results of their experiments.

ANIMALS IN WINTER

Pages: 88–90

Concepts:

- Some animals rest (hibernate) all winter.
- Some animals stay in their holes in stormy weather and come out on sunny days.
- Some animals stay in their holes during the day and come out at night to hunt food.

Suggested Questions:

What do you think is happening to the animals we saw in autumn?
What are toads, turtles, and snakes doing?

Suggested Activities:

The purpose of these pages is to teach a step in scientific method, that of checking on activities that have been started; also, to bring to the children's attention the animals which are hibernating. Though the word *hibernate* is too difficult for their reading vocabulary, the children may use it in speaking of the animals. It is incorrect to say that the animals are sleeping. Hibernation is a dormant state in which all the body processes are much slowed down. A hibernating toad or frog has no perceptible breathing, absorbing oxygen through its moist skin. It feels cold to the touch and the heart barely beats. If you bring it into a warm room it will slowly return to normal. This is an interesting activity for children to watch.

The pictures on pages 88 and 89 show the way these animals should be kept in winter, outside the window. Be sure that they have enough dirt, leaves, or sand to be well protected from the cold. Otherwise, they *may* freeze and die.

BULBS

Pages: 91–94

Concepts:

Bulbs may be planted with stones around them in bowls of water.
They should be kept in the dark until roots grow.
When roots have grown on the bulbs, they should be put in a light place. Roots get water for the plant.
Stems, leaves, and flowers grow from the bulbs.

Suggested Questions:

Do you know of a bulb that we eat?
Have you seen onions sprout?
What do you think a bulb would have to have to make it grow?

Suggested Activities:

Since most children are familiar with onions, the teacher might have an onion and a narcissus bulb for the children to compare. If possible, the children should have the experience of planting bulbs, using shared suggestions of teacher and children. The planting may be either a group or individual activity. Glass custard cups make individual bowls large enough for one bulb. Glass jars, such as those canned chicken or other foods come in, also may be used. The joy that a child feels in having a plant of his own is worth the extra effort on the part of the teacher.

The children can be shown the brown bulbs and stimulated to wonder what will grow from the bulbs if they are planted and watered properly. The teacher can then direct the planting of the bulbs in the dish or dishes, with the stones for support so the roots can grow to the bottom of the dish. Water to cover the bulbs and stones is put into the dish. The children are told that water must be kept on the bulbs; when it gets low, more must be added. The children then place their dishes in a cool, dark place, such as a cupboard, and wait to see what will happen. When the leaves begin to grow, the dishes should be brought out into the light. Three or four weeks will be required for a bloom to mature, but of course the leaves will come along and the children will be delighted with the progress of their plants.

If some children want to try growing bulbs some other way, let them try it. If enough water is present in a bulb, it may sprout, even without being planted, but it will grow only a short time.

Although first-graders may be too young to understand food storage by plants, if they ask questions about it, they should be given a correct, simple answer, not an evasive or inaccurate one. The bulb is an enlarged bud in which food is stored in fleshy leaves. These fleshy leaves surround the stem, at the tip of which is the growing point. As the stem and leaves grow from the bulb, the bulb becomes soft and flabby. This helps the children to see that food has been used. It the children are curious about what is inside the bulb, a bulb may be cut open. Sometimes a bulb that has been sliced lengthwise may be tied together and made to grow. The pictures on pages 136 and 137 of WINTER COMES AND GOES show a bulb that has been cut.

This story introduces the parts of a plant: roots, stems, leaves, buds, and flowers. If the teacher can show the children several kinds of bulbs and let them identify the parts of other common plants, it will help to fix these parts in their minds. The children should compare bulbs with seeds and discuss the fact that flowers form seeds while bulbs grow underground.

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